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EDWARD J. NOLAN,
Recording Secretary.

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PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1903.

JANUARY 6.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Twenty-one persons present.

The Council reported that the following Standing Committees had been appointed to serve during the ensuing year:

ON LIBRARY.—Dr. C. N. Peirce, Thomas A. Robinson, Henry C. Chapman, M.D., Charles Schaeffer, M.D., and George Vaux, Jr.

ON PUBLICATIONS.—Henry Skinner, M.D., Henry A. Pilsbry, Sc.D., Philip P. Calvert, Ph.D., Witmer Stone, and Edward J. Nolan, M.D.

ON INSTRUCTION AND LECTURES.—Benjamin Smith Lyman, Thomas H. Montgomery, Ph.D., Henry A. Pilsbry, Sc.D., Charles Morris, and Philip P. Calvert, Ph.D.

ON FINANCE.—Isaac J. Wistar, William Sellers, John Cadwalader, Edwin S. Dixon, and the Treasurer.

COUNCIL'S COMMITTEE ON BY-LAWS.—Isaac J. Wistar, Theodore D. Rand, Arthur Erwin Brown, and Thomas H. Fenton, M.D.

The President is, *ex-officio*, a member of all Standing Committees.

Mr. George Vaux, Jr., was appointed the Solicitor of the Academy.

January 13.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Twelve persons present.

The death of Bushrod W. James, M.D., a member, was announced.

January 20.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Sixteen persons present.

Papers under the following titles were presented for publication:

"Myriapoda from Beulah, N. M.," by Ralph V. Chamberlain.

"List of the Polycestid Gregarines of the United States," by Howard Crawley.

Preparation of Diatoms.—Mr. Frank J. Keeley called attention to a method recently employed in studying the structure of diatoms, which is supplementary to those previously described by him:—

Mounting broken valves on edge so as to obtain a sectional view, and mounting in a manner that permitted of successively immersing the forms in media of varying refraction indices.

The present method consists in depositing on the diatoms a thin film of silver, using the solution ordinarily employed for silvering mirrors, which, if dropped on the cover-glass containing the diatoms, will silver the latter to a considerable extent before any appreciable quantity of the metal is deposited on the glass. The finer the irregularities on the surface the heavier will be the deposit of silver, and the best results are obtained on gatherings containing broken and corroded forms, separated plates, etc., the structure of which becomes quite apparent. Thus conclusions can be drawn as to the correct nature of a complete and perfect valve which will be more accurate than when it is itself examined, particularly if the markings are fine, when they become filled with silver.

Under favorable conditions, after mounting in balsam and examining by transmitted light, valves or portions of them may be found having the appearance of plates of perforated metal, and while the results so far have principally been corroborative of those obtained by previous methods, some features not distinguishable under ordinary conditions are rendered apparent, among which may be mentioned a ring of processes near the margin of the valve of *Coscinodiscus subtilis*, which extends toward the interior of the frustule.

The character of the raphe is particularly well displayed in *Navicula* and its allies, as well as the small channels in the central and terminal nodules, which doubtless have some function in connection with the

protoplasmic currents causing the motion of diatoms. In *Navicula rhomboides* it becomes apparent that the raphe is single as in other species of this genus, and that the double raphe, based on which this form has been placed in a separate genus, is an optical illusion.

This process differs from that by which the late A. Y. Moore plated diatoms, as his were covered with a heavy layer of silver or gold and examined as opaque objects. It is rather a staining process, but likewise differs from the methods of Moore and others in this direction, which filled the cavities in the valves with opaque matter, while in this case the silica itself is rendered opaque, or nearly so.

As in all microscopical investigation, it is necessary to use judgment in interpreting appearances seen, as they will vary materially in the same species, depending on whether the entire structure is preserved. *Isthmia* affords an excellent example. Some valves may be found in which the coarse markings appear as holes in the blackened silica, showing that the secondary structure is entirely gone. Others will show the secondary structure in a similar manner as holes in a darkened plate, but still others will have the large oval markings entirely covered with a film of silver, indicating that there is a still finer and ordinarily invisible "tertiary structure" or plate, which serves as a basis on which the silver is deposited. Exactly the same conditions may be noted on the external plate of *Coscinodiscus asteromphalus*, but there is never an indication that the eye-spots on the inner plate are anything but clear openings.

JANUARY 27.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Twenty-two persons present.

The following were elected members: James Spear, Henry A. Lang, and Edw. B. Meigs.

William Morton Wheeler, of Austin, Tex., and Theodore Boveri, of Würzburg, were elected correspondents.

The following were ordered to be printed:

BIRDS OF THE SISKIYOU MOUNTAINS, CALIFORNIA: A PROBLEM IN DISTRIBUTION.

BY MALCOLM P. ANDERSON AND JOSEPH GRINNELL.

The birds of the following list were taken or observed by Malcolm P. Anderson in the extreme northwestern part of California, between September 6, 1901, and March 10, 1902. His field-notes form the basis of the present paper, while Joseph Grinnell is responsible for the critical remarks on specimens and distribution.

The region explored occupies the northwestern corner of Siskiyou county, close to the Oregon boundary. Most of the observations pertain to the region of Horse and Seiad creeks, which head in the Siskiyou range. Horse creek flows into the Klamath river from the north about four miles below the old mining camp called Oak Bar, and about nine miles above the mouth of Scott river. Seiad creek joins the Klamath near Seiad Post Office, which is eleven miles below Scott river, and therefore twenty miles from Horse creek. Although these two streams empty so far apart they head near together, there being but one ridge between the main branch of each.

Oak Bar is at an approximate altitude of 2,800 feet, while the crest of the Siskiyou Mountains, some seventeen miles north of the Klamath river, is 7,000 feet in elevation. The highest points of the range in the neighborhood of Horse creek approach 8,000 feet. West of Seiad creek the country changes abruptly, becoming far rougher, with the peaks in some instances rising higher. Near the mouths of both Horse and Seiad creeks the canyons expand into valleys, which are occupied by a few farmer-miners. The valley of Seiad creek is much the larger and is known as Seiad Valley. After the first of November camp was made about ten miles up Horse creek, at a little farm called Grater's ranch.

The region under consideration is covered with an open forest extending from the Klamath up to within a few hundred feet of the summit of the range. Here the trees become scattering and in places give way to large stretches of chaparral, with here and there meadows in which grass grows waist high unless disturbed by cattle.

The Life Zones represented in the region seem to be: Transition, which extends from the Klamath up to about the 6,000-foot contour line, and Canadian, which caps the range, with perhaps dilute Hudsonian in

places. The following trees identified will give a better idea of the conditions among which the birds were found:

Trees of the Transition Zone.

Pseudotsuga mucronata. Douglas Spruce.

This is the most conspicuous tree of the region. On Horse creek it is found from the Klamath up to an altitude of 5,500 to 6,000 feet.

Libocedrus decurrens. Incense Cedar.

This was also a very common tree from the Klamath up to about 5,000 feet.

Pinus lambertiana. Sugar Pine.

This is the largest tree of the region, and is common along the summits of White Cloud and Johnny O'Neil ridges from the Klamath up. It is most abundant and of greatest size in the basin of Salt creek about a mile from Grater's. Not observed above 4,500 feet.

Pinus ponderosa. Yellow Pine.

Seen from the Klamath up to about 4,000 feet; frequently of large size.

Pinus attenuata. Scrub Pine.

This tree grows commonly in the upper part of Seiad Valley, and was noticed along Seiad creek up to 4,000 feet.

Quercus californicus. Black Oak.

Though there are several species of oaks in the region, the only one that is very conspicuous is the California black oak. It is found from the Klamath to an elevation of about 4,000 feet. In several places it forms groves of considerable size to the exclusion of coniferous trees.

Arbutus menziesi. Madrone.

Seen frequently among the oaks up to their limit.

Alnus sp.?

A species of alder grows along all the streams.

Acer macrophyllum. Big Leaf Maple.

Observed along streams, but limits not noted.

Trees of the Canadian Zone.

Abies magnifica shastensis. Shasta Fir.

This tree mixes with the following in the upper edge of Transition, and extends throughout the Canadian zone.

Abies concolor lowiana.

A fir probably referable to this form is found in the lower portion of Canadian and higher Transition, where it occurs in company with the Douglas spruce. In the canyon of Horse creek it was seen down to an altitude of 3,100 feet.

Pinus monticola. Mountain Pine.

This tree is frequent in the Canadian zone, to which it seems restricted.

Hudsonian Zone.

Tsuga mertensiana. Black Alpine Hemlock.

Hemlocks grow in abundance near the head of the east fork of Horse creek and elsewhere along the range in cool places. During a tramp along the crest this tree was seen repeatedly.

Notes on the Birds of the Region.

Ardea herodias herodias. Great Blue Heron.

On January 25 a great blue heron was seen on Seiad creek, about four miles above the mouth. Again, on March 2, two herons were observed on the Klamath river, between Oak Bar and Walker Post Office.

Oreortyx pictus plumiferus. Mountain Partridge.

On September 12 a small boy brought in two quail which had been shot near the house on Grater's Ranch. Subsequently the species was detected only once: a flock of six or eight were seen in Seaid Valley on December 20. The two September birds were preserved, and in spite of extremely abraded plumage, are plainly referable to *plumiferus*, and not *pictus*, as one might expect. One of the specimens is adult and shows a few new feathers appearing on the scapulars, breast and sides, but there is no evidence of approach toward the brown-necked humid coast form. This is an interesting example of the westward extension of a Sierra Nevadan form.

Bonasa umbellus sabinei. Oregon Ruffed Grouse.

The people of the Siskiyou state that this bird is invariably seen on the ground or on fallen logs. The observations of the past winter go to confirm this, for all the grouse seen were upon the ground or flying near it, and in all cases were in groves of small Douglas spruce, such as grow near or in the canyon bottoms. There is another grouse known to the inhabitants of this region. This bird is said to be found mainly in trees and is doubtless the sooty grouse (*Dendragapus obscurus fuliginosus*). In the latter part of February and early in March, the drumming of what was thought to be this latter species was heard, but not even a glimpse was obtained of the performer. Four specimens of the

Oregon ruffed grouse were preserved, and the species may be considered fairly common through the winter in this region. This bird has been found previously in California only in the redwood forests in the vicinity of Humboldt Bay, so that the present record extends its known range considerably to the eastward. Douglas, in the original description of his "Tetrao Sabini," gives its range as "from Cape Mendocino" north, etc. But recent records, up to the present, indicate ordinarily a dense forest habitat.

Buteo borealis calurus. Western Red-tailed Hawk.

An immature male red-tail was shot on October 11 on the very summit of the Siskiyou, where the Oregon trail crosses.

Falco sparverius phalæna. Western Sparrow Hawk.

One was observed on March 2 between Oak Bar and Walker on the Klamath.

Ceryle alcyon. Belted Kingfisher.

A single individual was observed flying up Horse creek on January 16.

Dryobates villosus harrisi. Harris Woodpecker.

This bird is very common in the groves of black oak which are located here and there on the lower parts of the Siskiyou range. It is also found in the coniferous forests, though in smaller numbers. From October 24 to February 15 fifteen specimens were taken. These are variously intermediate in coloration between *hyloscopus* and *harrisi*, but average nearest the latter. Five of the birds have all the white areas strongly suffused with smoke-gray or brown, nearly but not quite as deeply as in specimens from western Oregon and Washington. Four have all the areas practically pure white, while the other six are fairly intermediate between these two types. The whole fifteen present an uninterrupted series, from the whitest to the dingiest. The usual size of all the specimens, however, is that of *harrisi;* that is, decidedly larger than the white-breasted *hyloscopus*, which occupies nearly the whole of California in favorable localities outside of the extreme northern humid coast belt.

Dryobates pubescens gairdneri. Gairdner Woodpecker.

The Gairdner woodpecker is usually to be found in company with the flocks of mountain chickadees which frequent the black oak groves all winter. The oaks are their favorite working places, but they are also to be seen among the pines and spruces. The six specimens brought home are all quite near *gairdneri*. The smokiness of the lower surface is not so intense as in skins from western Oregon, but the size, especially of the feet, is decidedly that of the northwest coast form.

Gairdneri occurs in California only in the extreme northwestern corner of the State, the greater portion west of the Sierras being occupied by *D. p. turati*. (See Fisher, *Condor*, IV, May, 1902, 68.)

Xenopicus albolarvatus. White-headed Woodpecker.

Only three birds of this species were seen in the Siskiyou region. All were shot from sugar pines in the neighborhood of Salt creek. They were obtained on October 10, January 10 and February 19, respectively. These specimens are exactly like the small-billed Sierra Nevadan birds. The known range of the species is thus materially extended, and here seems to be its westernmost station.

Sphyrapicus varius ruber. Red-breasted Sapsucker.

This woodpecker was not infrequently seen along Horse and Seiad creeks, mostly in the spruce forest at about 3,200 feet elevation. While not the extreme manifestation of *ruber*, the four specimens secured, by their large size and dark coloration, easily belong under this head. The white markings of wings and tail are much more restricted than in the Sierra Nevadan *daggetti*.

Sphyrapicus thyroideus. Williamson Sapsucker.

A single individual was found on a ridge above camp on December 19. It was at work in a tall Douglas spruce, and continued tapping lightly until closely approached. This proved to be a female, and is darker colored than Sierran specimens compared with it. The head is browner, while the deeper yellow belly and extreme length of wing point toward a geographical variation perhaps parallel to *S. v. ruber*.

Ceophlœus pileatus abieticola. Northern Pileated Woodpecker.

The pileated woodpecker is one of the most conspicuous birds of the region. Its loud screech-like call can be heard for many hundred yards across the canyons. Though often seen it is very wary and difficult of approach. Its favorite resorts seem to be the black oaks, but occasional birds are seen to alight in coniferous trees. One specimen had the stomach distended with large black ants, which it was gathering from an oak when shot. As shown by the following measurements (in millimeters), the four specimens procured belong to the large northern race. There appear to be no significant differences between these and skins from the north Atlantic slope.

Collector's No.	Date.	Wing.	Tail.	Tarsus.	Bill from Nostril.
♂ 56	Oct. 9	238	187	35	41
♀ 63	" 13	226	179	36	40
♀ 141	Dec. 19	225	175	37	36
♀ 156	" 27	226	180	35	38

Melanerpes torquatus. Lewis Woodpecker.

The first bird noticed on crossing the Klamath and entering Horse creek canyon was the Lewis woodpecker. The species was then, September 6, abundant in oaks bordering the meadows near the mouth of the creek. On September 13, two specimens were shot from a spruce near Grater's farmhouse. There were a number of others about at the time, but at the report of the gun they made off down the canyon, and nothing was afterward seen of the species anywhere in the region. It probably occurs only as a migrant.

Colaptes cafer saturatior. Northwestern Flicker.

Flickers were seen in the yellow pine forests on the ridge west of camp all through the fall and early part of winter, but they were so excessively shy that none were secured until January 20. They were always abundant near the mouth of Seiad creek, in some open meadows lined with oaks, and alders overgrown with wild grapevines. As compared with specimens from the vicinity of Monterey, the type locality of *collaris*, the three skins from the Siskiyou country show somewhat greater dimensions and also darker colors. This is especially noticeable on the back, which is a decidedly richer brown, the ground color being deep Prout brown.

Sayornis saya. Say Phœbe.

On September 16 a Say phœbe was shot from its perch on the barn at Grater's place. This was the only bird noted, and so is probably represented in the region only as a migrant.

Cyanocitta stelleri carbonacea. Coast Jay.

This was the only jay detected in the Siskiyou Mountains, and was by no means as conspicuous as jays often make themselves. Only occasionally was one heard scolding in some cluster of spruces, or discovered hopping quietly from limb to limb in a black oak. Eight skins were obtained during the winter, and all proved to be quite typical of the humid coast race *carbonacea* (see Fisher, *Condor*, IV, March, 1902, 41). But a female specimen taken at Walker Post Office, Siskiyou county, March 11, 1902, is very different, approximating *C. s. frontalis*, though not as pale as the average of southern California birds. Walker is only about twenty miles due east of Seiad Valley, and about forty-five miles northwest of Mt. Shasta. If this specimen represents the resident race of its locality, it furnishes a very interesting example of the possible close invasion of two races toward each other from their original separate centres of differentiation (until the area of intergradation may ultimately disappear).

Corvus americanus hesperis. California Crow.

On October 1 a large flock of crows were noted on a meadow near the mouth of Horse creek. Later in October a single individual was seen in a meadow at Grater's. Numbers were observed along the Klamath near Oak Bar toward the middle of March (6th and 11th).

Nucifraga columbiana. Clarke Nutcracker.

Two individuals were observed on December 29 on the ridge between Horse and Salt creeks. Mr. Doney, a miner of more than ordinary intelligence and veracity, stated that this bird is common on the highest parts of the Siskiyou all through the summer. This is another indication of the presence of a Hudsonian zone on these mountains.

Carpodacus purpureus californicus. California Purple Finch.

A male specimen was secured on February 1 on the ridge between Horse and Salt creeks. The bird was at the top of a large oak singing loudly. We took the singing as a sign of spring coming, but we had severer weather after that than before.

Astragalinus psaltria psaltria. Arkansas Goldfinch.

Soon after reaching Grater's ranch, September 7, these birds were common in a pasture near the house. But within a few days, and before specimens were secured, they took their departure.

Junco hyemalis hyemalis. Slate-colored Junco.

A single male specimen was shot on January 25 from a black oak in the dooryard at Grater's. There were other juncos about at the time, but all seemed to be of the Oregon form. This skin measures, wing 78 mm., tail 71. The tips of the dorsal feathers are slightly brownish, but the bird agrees explicitly with selected north-Alaskan and Atlantic coast specimens. This makes about the twenty-second instance of the occurrence of this form in California.

Junco hyemalis oreganus. Oregon Junco.
Junco hyemalis thurberi. Sierra Junco.

Juncos seemed to constitute the most common species throughout the Transition of the Siskiyou region. Not a day passed without numbers being seen. On and after December 4, when the first snow fell, they became very common about camp, where they worked continually in the old garden. Out of sixteen skins brought home, six are at a glance recognizable as *oreganus:* they are just like Seattle and Sitka specimens. Four others are just as typically *thurberi* when compared with Mt. Wilson skins, while the remaining six are partly immature and are less precisely referable. It might be surmised that the Oregon

juncos are winter visitants, while the *thurberi* type is the resident form, but this is pure conjecture.

Melospiza cinerea merrilli. Merrill Song Sparrow.

Two specimens of this song sparrow were taken on October 30 and December 14 respectively, from a tangle of blackberry briers near camp. These are much paler than *morphna* and *phæa*, with decidedly blackish streaks both on back and breast, thus approaching *montana* closely. It seems probable that it is this form that breeds in the region.

Collector's No.	Wing.	Tail.
♀ 130	66	70
♀ 70	65	71

Melospiza cinerea morphna. Rusty Song Sparrow.

A bird of this race was taken on November 6 from the tangle of briers in which the Merrill song sparrows were found. Another was taken later from a band of sparrows in Seiad Valley. The first of these (No. 78) inclines in paleness of hind neck and back toward *merrilli*. The other is nearer *phæa* in having a sooty streaking. But the large size in both cases places them rather in the *morphna* category.

Collector's No.	Wing.	Tail.
♂ 110	71	76
♂ 78	69	77

Passerella iliaca unalaschcensis. Shumagin Fox Sparrow.

On October 9 two fox sparrows were taken from the same thicket mentioned in connection with the foregoing. These seem to be nearest *unalaschcensis*, though inclining toward *meruloides* in brownness of coloration. They are too small for *insularis*. Making due allowance for wear, they are counterparts of summer specimens at hand from Prince William Sound, Alaska, which is about half-way between the metropolis of *meruloides* (Yakutat Bay) and that of *unalaschcensis* (Aliaska Peninsula).

Piranga ludoviciana. Western Tanager.

A single specimen was shot from a sugar pine on White-Cloud ridge on September 12, evidently in migration.

Vireo solitarius cassini. Cassin Vireo.

The only specimen observed was secured September 12 from some alders bordering a small stream on White-Cloud ridge, doubtless in migration.

Vireo huttoni huttoni. Hutton Vireo.

Hutton vireos were found frequenting that part of the Transition zone in which oaks are most numerous, but were also often seen feeding in spruces. They remained throughout the winter in uniform numbers.

There seems to be absolutely no difference between the six Siskiyou skins and a series from the Santa Cruz Mountains and vicinity of Monterey, the latter being the type locality of *huttoni.* Monterey is in the southern extremity of the humid coast Transition, and there has always seemed a doubt as to the existence of a race *obscurus* in the northern part of the same belt. S. N. Rhoads, in the *Auk*, Vol. X, July, 1893, p. 238, clearly pointed out the untenability of *obscurus*, but no one seemed to pay any attention to his remarks. As to the existence of a really distinct form on Vancouver Island (*V. h. insularis* Rhoads), we have as yet no specimens to indicate it. Looking at Anthony's description of *obscurus*, we find that he used southern California birds in comparison with his Oregon ones. Some skins now at hand from Pasadena, in moderately worn spring plumage, are not so green dorsally and laterally as birds of the same season from the Santa Cruz district. This is evidently due to the greater rate of fading and abrasion in the arid southern climate, for the majority of specimens in fresh fall plumage are indistinguishable, and equivalent extremes are to be picked out of both series. Sixty specimens have been examined in this connection.

Dendroica auduboni. Audubon Warbler.

A male was shot from a small flock on the west side of White-Cloud ridge on September 12. After that none were seen.

Cinclus mexicanus. American Dipper.

Fairly common from the Klamath up Horse and Seiad creeks to an altitude of 5,000 feet. Five skins were preserved.

Troglodytes hiemalis pacificus. Western Winter Wren.

This proved to be a common bird of the Siskiyou region, where it was almost always to be found in the blackberry tangles along the smaller streams. Seventeen skins secured serve only to emphasize the geographical uniformity of this race in its long north-and-south range.

Certhia americana zelotes. Sierra Creeper.

Creepers are comparatively numerous in the region of Horse creek. They were often seen busily searching about the bases of the Douglas spruce or hurriedly climbing spirally up the trunk of some pine or oak. The eleven specimens procured do not seem to differ in the

least from Sierran birds. Nor do they look much different from Sitkan skins. However, we have no certified examples of *occidentalis*, which is a supposedly distinct form said to occupy the humid northwest coast belt.

Sitta carolinensis aculeata. Slender-billed Nuthatch.

This bird was seen everywhere from the Klamath river to the upper edge of Transition. It seems to lead the mixed flocks of *Parus*, *Regulus*, etc., with which it is nearly always seen. Seventeen specimens were obtained.

Sitta canadensis. Red-breasted Nuthatch.

The Canada nuthatch was far less conspicuous than the preceding species, though it was probably no less common. It also accompanied the mixed flocks of chickadees and kinglets to some extent, but seemed to prefer the coniferous trees to the oaks which the slender-billed nuthatch so largely frequents. Previous to December 26 no individuals were seen. The specimen shot on that date was rather high up in Transition, and was, it seems probable, just descending from the Canadian zone. For the species was shortly afterward common.

Parus gambeli. Mountain Chickadee.

This chickadee was constantly present among both the oaks and coniferous trees throughout Transiton and up into lower Canadian. The fourteen specimens brought home have on an average smaller bills than a series from the mountains of southern California (just as with *Xenopicus*). This is the westernmost record for this species.

Parus rufescens rufescens. Chestnut-sided Chickadee.

This bird was almost always found in company with the mountain chickadee, forming mixed roving bands. The series of twenty-one specimens is uniform and quite like birds from Sitka and Oregon. It would be highly important to know whether this species and the last occur together in summer also, and breed in the same locality.

Psaltriparus minimus. California Bush-tit.

This was another very common bird in the black oak forests, but occurred in the coniferous woods as well. It was not, however, observed above the limit of *Pinus ponderosa*. The ten specimens taken present no differences from corresponding plumages of birds from central and southern California. Nor are there any characters to discriminate the few specimens we have from Oregon and Washington from those from California. Judging from the specimens at hand, there is little or no evidence of a race *californicus*. There is considerable

variation in shade of back and pileum due to wear and fading, but the fresh fall birds all look alike.

Regulus satrapa olivaceus. Western Golden-crowned Kinglet.

This bird, when observed at all, was always in the flocks of chickadees and nuthatches. Seven specimens, all males, were secured during the winter.

Hylocichla guttata nana. Dwarf Hermit Thrush.

On December 20 the only small thrush seen was shot from an alder in Seiad Valley. This specimen, on account of its small size and brown coloration, is easily referable to the northern humid coast form *nana*.

Merula migratoria propinqua. Western Robin.

Seen occasionally throughout the winter, almost always with the varied thrushes. It ranges from the Klamath river up to the limit of the black oak timber at least.

Ixoreus nævius nævius. Varied Thrush.

The varied thrush, although seen throughout the winter, was not common until January, when large flocks appeared on the meadows in Seiad Valley. (This valley is almost free from snow). When the snow left the meadow at Grater's during February, numbers of these thrushes appeared there. At the same time they became common in the oak forests. Sixteen specimens were preserved. These average in characters close to the Sitkan form.

Sialia mexicana occidentalis. Western Bluebird.

A male bluebird was shot from a small flock on White-Cloud ridge, September 12. After this none were seen until February 9, when a bird appeared near camp. They soon after became common both in the vicinity of Grater's and in Seiad Valley.

Summary.

The foregoing list is a remarkable one as showing the association of a number of birds not usually found together. The Siskiyou Mountains are evidently on the narrow line of mergence between the humid coast fauna and the arid Sierran fauna. Representative species of the two areas are here found in about equal numbers, in winter at least, as shown by the following comparative table:

Humid Coast Fauna.	Arid Sierran Fauna.
Bonasa umbellus sabinei,	*Dendragapus obscurus fuliginosus,*
Dryobates villosus harrisi,	*Oreortyx pictus plumiferus,*
Dryobates pubescens gairdneri,	*Xenopicus albolarvatus,*
Sphyrapicus varius ruber,	*Sphyrapicus thyroideus,*
Colaptes cafer saturatior,	*Nucifraga columbiana,*
Cyanocitta stelleri carbonacea,	*Certhia americana zelotes,*
(*Junco hyemalis oreganus,*)	*Junco hyemalis thurberi,*
(*Melospiza cinerea morphna,*)	*Melospiza cinerea merrilli,*
Parus rufescens rufescens.	*Parus gambeli.*

In the case of species represented in both areas but by distinct subspecies, sometimes it is the humid form that is present and sometimes the arid form (in a few cases there are intermediates). For instance, we find the typical coast form of *Cyanocitta*, but the typical arid race of *Oreortyx*. And in the case of distinct species, as a result of eastward and westward invasion respectively, the ranges of the separate representatives here overlap; for example, *Parus rufescens* and *Parus gambeli*. We find that as a rule two faunæ (of the same zone) are occupied each by a different subspecies of the same species, or a different species of the same genus; and that a single genus is seldom represented in one fauna by more than one species. (If it is, then it seems to have come through the invasion of one of the congeneric forms from an adjacent fauna, as with the two chickadees just mentioned.) This seems to me a strong argument in favor of the theory that isolation (either by long distance or intervention of barriers) has been an absolutely essential condition to the differentiation of species. A fauna is a certain assemblage of animals occupying a given uniform area; but the proportionate composition in both species and individuals is constantly changing, as influenced by neighboring faunæ, as well as endemic factors.

ON THE TERRESTRIAL VERTEBRATES OF PORTIONS OF SOUTHERN NEW MEXICO AND WESTERN TEXAS.

BY WITMER STONE AND JAMES A. G. REHN.

In the spring and early summer of 1902, Mr. H. L. Viereck and the junior author spent about eleven weeks in the Sacramento Mountain region of south-central New Mexico. The expedition was undertaken in the interest of the Academy, under the direction of the Board of Curators, and quite extensive collections of plants and insects as well as a fair representation of other groups were secured.

The localities visited and represented by specimens in the collections are as follows:

Ysleta, El Paso county, Tex. Elevation, 3,664 feet. A village along the Rio Grande a short distance below El Paso. April 2d to 4th was spent here, and collecting carried on in the cultivated strip between the river and sand hills ("bosque"), and also in the latter very unproductive section.

El Paso, Tex. Elevation, 3,713–4,000 feet. Collecting was pursued in the foothills of the Franklin Mountains to the north of the city. March 31st and April 4th to 6th were spent in this vicinity.

Alamogordo, Otero county, N. M., and vicinity. Elevation, 4,320 to 4,600 feet. This section was quite thoroughly examined, collecting being carried on by both members from April 7 to May 24, and by Mr. Viereck during several days in the earlier part of June. Alamogordo is situated in the broad San Augustine plain, two miles from the foothills of the Sacramento range, to which latter almost daily trips were made. The characteristic vegetation of this desert plain is greasewood or creosote bush (*Larrea*) and mesquite (*Prosopis*), with scattered cactus (*Opuntia*) and Spanish bayonet (*Yucca*), the latter becoming more abundant toward the foothills.

Dry Cañon, Otero county, N. M. Elevation about 4,600–5,000 feet. This cañon, being easiest of access from Alamogordo, was visited almost daily. The reptiles, insects and plants of this rather circumscribed region were very thoroughly collected.

Alamo Cañon, Otero county, N.M. Elevation about 5,000–5,300 feet. This cañon is considerably larger than the foregoing and contains a constant stream of pure water. It is located about seven miles southeast

of Alamogordo, and collections were made here April 11, 16, and on several other occasions by Mr. Viereck.

Laluz Cañon, Otero county, N. M. Elevation at mouth about 5,000 feet. This cañon is about the size of Alamo Cañon, and contains a large stream of discolored alkaline water, locally known as the Laluz river. Laluz Cañon is located seven miles northeast of Alamogordo, and extends a great distance into the range, a portion of it being occupied by the railroad which reaches the upper slopes of the mountains. Several days were spent here collecting.

Highrolls, Otero county, N. M. Elevation about 7,000 feet. This locality is about half-way up the Sacramento range, and was visited by Mr. Viereck early in June.

Cloudcroft, Otero county N. M. Elevation about 9,000 feet. Cloudcroft is located practically on the top of the Sacramentos, and collecting was carried on there by Mr. Viereck during the latter part of May and the early part of June.

While the authors are not prepared to enter into a lengthy dissertation on the faunal relations of the localities visited, still the general conclusions drawn from an examination of the material collected may prove worthy of record. Leaving the Texas localities out of consideration, as but little vertebrate material was obtained there, we come first to the immediate vicinity of Alamogordo. This appears to be truly Lower Sonoran (or Middle Sonoran, as has been proposed[1]), the vegetation, the most characteristic species of which have been mentioned before, as well as the reptiles, mammals, birds and insects, so far as studied, being characteristic of this zone. This fauna and flora seem to extend quite a distance up the bottoms and arroyos (torrent beds) of the cañons, while the slopes of the same and the foothills appear to possess more distinctly Upper Sonoran types, such as the sotol (*Dasylirion*), candle-wood (*Fouqueira*) and junipers (*Juniperus*). The piñon (*Pinus* sp.) does not extend so ar down as the juniper, and makes its appearance only when Lower Sonoran types have totally disappeared from the arroyos. In Dr. C. Hart Merriam's latest faunal map of the United States two tongues of the Lower Sonoran are shown to enter New Mexico from the south, one along the valley of the Rio Grande and the other along the Pecos. From a study of the present material, it would seem that another Lower Sonoran tongue branches off from the

[1] The evidence on which this division was made does not appear sufficient. On almost equal grounds we might divide the Carolinian belt into at least two portions.

Rio Grande tract and runs up between the Organ and the Sacramento ranges, comprising the San Augustine plain.

Highrolls is situated near the lower border of the Transition zone, and possesses few types in common with Alamogordo, but shares quite a number with Cloudcroft. The latter locality is situated in heavy Canadian forests, throughout which are interspersed open glades. The fauna and flora of Cloudcroft are pure Canadian, and the surrounding timberland is one of the most important sources of lumber in the southwest.

Considerable material other than that collected by the expedition was examined in the preparation of this paper. In such cases full credit is given to the sources from which these specimens were obtained. We are, however, under especial obligations to Mr. Gerrit S. Miller, Jr., of the United States National Museum; Dr. J. A. Allen, of the American Museum of Natural History, New York, and Dr. C. Hart Merriam, Chief of the Biological Survey, United States Department of Agriculture, for the loan of specimens of mammals.

While concurring in the identifications and statements contained in the following pages, the authors would have it understood that Mr. Rehn is responsible for the portion on mammals and Mr. Stone for the birds and reptiles.

MAMMALS.

Sciurus fremonti lychnuchus n. subsp.

Type: No. 11,105, Coll. Acad. Nat. Sciences of Philadelphia. ♂ Forks of Ruidoso, Lincoln county, N. M. August 18, 1898. Collected by C. M. Barber.

Related to *S. f. neomexicanus* Allen, but differing in the larger size, more rufous coloration and in the much more elongate nasals.

Distribution.—This form is at present represented only by material from the White Mountain region, but probably occurs also in the Capitan and Sacramento sections.

Color.—Above dull ferruginous, strongest on the median section, the color clearer and most intense on the rump, where the usual faint blackish vermiculations are almost absent. Sides above the lateral line pale rufescent with an ochraceous tinge; lateral line narrow, not very distinctly defined and with many ochraceous hairs intermingled. Head washed with blackish, the orbital ring clear white; ears externally ferruginous touched with blackish at the apex, which bears a scant pencil. Fore limbs clear rufescent above, the lateral fringe of the feet silvery white. Hind limbs dull ferruginous, becoming rufescent on the

upper surface of the feet. Tail above centrally rich ferruginous, most intense basally, lateral fringe with the basal portion of the hairs black, the apical section pale ochraceous, the black becoming more extensive toward the apex of the tail and forming an almost clear black bar about 20 mm. in length, the extreme tip being formed by the pale ochraceous tips of the hair. Lower surface of the tail pale grayish ochraceous, the successive black and ochraceous color divisions being marked as above; toward the apex of the tail a trace of the upper color is noticed suffusing the grayish ochraceous portion. Under surface, including the lips, chin, throat, under surface of the limbs and feet, whitish, pure on the throat, mixed elsewhere with the tint of the pale mouse-colored under fur.

Skull.—The skull of *S. fremonti lychnuchus* differs from that of *S. fremonti neomexicanus* in its more elongate form and slender and more attenuate nasals. The skull of *lychnuchus* is comparatively narrower than that of *neomexicanus*, and the zygomatic region appears compressed. The nasals average 1.7 mm. longer in *lychnuchus* than in *neomexicanus*, while they really average narrower in width by .2 mm.

Measurements.—Flesh dimensions of the type: Total length, 350 mm.; length of tail, 140; length of hind foot, 55. Average of three specimens (flesh measurements): Total length, 335 (326–350); length of tail, 140; length of hind foot, 53.3 (51–55). Average of seven specimens of *S. fremonti neomexicanus:*[2] Total length, 321 (308–330); length of tail, 133 (127–145); length of hind foot, 48.5 (45–52).

The type skull of *lychnuchus* measures as follows: Total length, 50 mm.; basilar length, 42; greatest zygomatic width, 29; length of nasals, 16; width of nasals, 8.2. The average of six skulls of the new form is: Total length, 49 (48–51); basilar length, 40.9 (40–42.2); greatest zygomatic width, 27.9 (27–29); length of nasals, 15.7 (15.5–16); width of nasals, 7.4 (7–8.2). Average of four skulls of *neomexicanus:*[3] Total length, 45.9 (43.5–47.3); length of nasals, 14.3 (13.7–15). The two skulls of topotypes of *neomexicanus* examined by us give the following measurements: Total length, 46.7 (46.5–47); basilar length, 39.7 (39–40.5); greatest zygomatic width, 27.7 (27–28.5); length of nasals, 14; width of nasals, 7.6 (7.5-7.7).

Specimens Examined.—Four skins from the type locality, Rio Ruidoso and Mescalero, all in the White Mountains. One of the skins and three additional skulls were from the collection of the American Museum of Natural History.

[2] Allen, *Bull. Amer. Mus. Nat. Hist.*, X, p. 291.
[3] *Ibid.*

Remarks.—While no specimens of *neomexicanus* in summer pelage are available, the great difference in color, aside from the larger size and distinctive cranial characters, lead to the opinion that a very distinct geographic form of the *neomexicanus* type is represented in this material. Two topotypes of the latter form from the collection of the Biological Survey were examined in this connection, and also four specimens (including the type) of *mogollonensis* from the American Museum collection. No close relationship exists with the latter form, which is of a more grizzled and smoky coloration, as well as having the skull rather different in character.

Eutamias cinereicollis canipes Bailey.

1902. *Eutamias cinereicollis canipes* Bailey, Proc. Biol. Soc. Wash., XV, p. 117, June 2, 1902. (Guadalupe Mts., El Paso county, Tex.)

The material at hand shows that this form is well distributed over the higher portions of the White Mountains, while information from a reliable source gives it as occurring at Cloudcroft. Material has been examined from the following localities: Forks of Ruidoso, Rio Ruidoso, Mescalero and Hale's Ranch, Ruidoso.

Compared with *E. cinereicollis*, (Allen) this form is readily differentiated by the diagnostic characters given by Bailey—the paler and duller ochraceous tints, the white tips to the hair on the upper surface of the tail, and by the grayer feet. One differential character which seems to have been overlooked in the original description is the absence of solid black in the lateral dorsal stripes. In all the specimens (7) examined these are mixed blackish and rusty, while in *cinereicollis* the centers at least are solid black.

Eutamias quadrivittatus (Say).

1823. *Sciurus quadrivittatus* Say, Long's Expedition to Rocky Mts., II, p. 45. (At the exit of the Arkansas river from the foothills, Colorado.)

One specimen from Canoncita, above Cleveland, Mora county, N. M., collected by Emerson Atkins, and submitted by Prof. Cockerell, is indistinguishable from specimens from Boulder, Colo.

Citellus spilosoma arens (Bailey).

1902. *Spermophilus spilosoma arens* Bailey, Proc. Biol. Soc. Wash., XV, p. 118, June 2, 1902. (El Paso, Tex.)

Three specimens of this form from the vicinity of Alamogordo, Otero county, N. M., are identical with a series from El Paso and Fort Hancock, Tex. A young specimen from Mesilla, N. M., is clearly referable to this form.

Citellus marginatus (Bailey).

1902. *Spermophilus spilosoma marginatus* Bailey, Proc. Biol. Soc. Wash., XV, p. 118, June 2, 1902. (Alpine, Brewster county, Tex.)

Two specimens from Pecos, Tex., and vicinity of Alamogordo, Otero county, N. M., agree perfectly with the description of this form. The inference drawn from the occurrence of *marginatus* in communities with *arens* is that they represent distinct species, the coloration being typical as well as the proportions. The length of the hind feet appears to be an excellent diagnostic character.

Citellus mexicanus parvidens (Mearns).

1896. *Spermophilus mexicanus parvidens* Mearns, Preliminary Diagnoses of New Mammals from the Mexican Border of the United States, p. 1, March 25, 1896. (Fort Clark, Kinney county, Tex.)

Three specimens of this form are included in the series examined, all being from Pecos, Tex. Two of the specimens are the property of the Academy, the other belonging to the American Museum. Compared with topotypes the Pecos specimens are seen to be identical, and are easily separated from Brownsville specimens, which latter appear to represent true *mexicanus*.

Citellus grammurus (Say).

1823. *S[ciurus] grammurus* Say, Long's Exped. Rocky Mts., II, p. 72. (Arkansas river, at its exit from the foothills, Colorado.)

A specimen from Rio Ruidoso, Lincoln county, appears to represent the typical form.

Citellus tridecemlineatus pallidus (Allen)?

1877. [*Spermophilus tridecemlineatus*] var. *pallidus*, Allen, Monogr. N. Amer. Rodentia, p. 872, August, 1877. (Plains of the lower Yellowstone river.)

A specimen of the thirteen-lined spermophile from Agua Fria Park, Colfax county, N. M., collected by Emerson Atkins, was submitted by Prof. Cockerell. While by no means true *pallidus*, still it appears to be closer related to this than to any other form. The condition of the specimen is quite unsatisfactory for conclusive comparison.

Cynomys arizonensis Mearns.

1890. *Cynomys arizonensis* Mearns, Bull. Amer. Mus. Nat. Hist., II, p. 305, February 21, 1890. (Point of mountain, near Wilcox, Ariz.)

An adult male of this species from the San Augustine plain (or Tularosa Valley), near Alamogordo, Otero county, N. M., appears to be absolutely identical with the Arizona form. On comparison the skull is found to be identical with representatives of *arizonensis* from San Luis Springs, Mexican boundary, determined by Mearns. The length of head and body considerably exceeds the maximum given in the original description.

This individual was from a small colony of about thirty holes.

Onychomys arcticeps Rhoads.

1898. *Onychomys arcticeps* Rhoads, Proc. Acad. Nat. Sci. Phila., p. 194. May 3, 1898. (Clapham, Union county, N. M.)

A series of eight specimens from the vicinity of Alamogordo, Otero county, N. M., appear to be much closer related to *arcticeps* than to *torridus arenicola* Mearns from near El Paso, Tex. The ears are considerably blacker than in *t. arenicola*, and the facial markings are more distinct, while the tail is much shorter.

Onychomys ruidosæ n. subsp.

Type: No. 11,091, Coll. Acad. Nat. Sciences of Philadelphia. ♀. Ruidoso, Lincoln county, N. M. September 19, 1898. Collected by C. M. Barber.

Apparently related to *O. melanophrys*, but differing in its more reddish coloration, darker head and ears, and in the narrower interpterygoid fossa.

Distribution.—Specimens from Hale's Ranch in the White Mountain region, have also been examined.

Color.—Above dull ferruginous, becoming almost clear rufous on the rump; head and nape blackish-gray washed with ferruginous; ears blackish-gray beset with fine silvery-white hairs, which are most abundant toward the apex; chin pale grayish-pink. Under surface, including fore and hind limbs (except posterior surface of hind legs), dull white, the under fur plumbeous. Tail rather thinly haired, with the upper surface mixed brown and white.

Skull.—The skull of *ruidosæ* closely resembles that of *melanophrys*, but differs in the broader rostrum and nasals, the more truncate occipital region, the narrower interpterygoid fossa and in the stouter and heavier condylar process of the mandible.

Measurements.—Flesh dimensions of type: Total length, 156 mm.; length of tail, 47; length of hind foot, 22.

Remarks.—While closely related to the *melanophrys* group, *ruidosæ* is a very distinct species. Relationship exists with *fuliginosus* Merriam and *torridus* Coues, but the former is immediately separated by the slenderer skull and weaker incisors, beside the narrower rostrum and nasals as well as the smaller auditory bullæ. From *torridus* it is easily differentiated by the deeper coloration, the grayer head and the more indefinite lateral line, as well as the much greater size.

Peromyscus texanus sonoriensis (Le Conte).

1853. *Hesperomys sonoriensis* Le Conte. Proc. Acad. Nat. Sci. Phila., p. 413. (Santa Cruz, Sonora.)

Three specimens from the vicinity of Alamogordo, Otero county,

N. M., appear indistinguishable from specimens of *sonoriensis* collected by the Mexican Boundary Survey.

Peromyscus truei (Shufeldt).

1885. *Hesperomys truei* Shufeldt, Proc. U. S. National Museum, VIII, p. 407, September 14, 1885. (Fort Wingate, N. M.)

Six specimens from Hale's Ranch, Ruidoso, Lincoln county, N. M., appear identical with a topotype from the collection of the U. S. National Museum. An apparently immature specimen from Las Vegas, collected by Emerson Atkins, and submitted by Prof. Cockerell, appears to be referable to this form.

Peromyscus tornillo Mearns.

1896. *Peromyscus tornillo* Mearns, Preliminary Diagnoses of New Mammals from the Mexican Border of the United States, p. 3, March 25, 1896. (Near El Paso, Tex.)

Specimens from Mesilla, Donna Ana county, and Clapham, Union county, N. M., are slightly darker than the type of *tornillo*, though apparently referable to the same form.

Peromyscus rufinus (Merriam).

1890. *Hesperomys leucopus rufinus* Merriam, North American Fauna, No. 3, p. 65, September 11, 1890. (San Francisco Mountain, Ariz.)

Six specimens examined from Forks of Ruidoso, Lincoln county, and Mescalero, Otero county, N. M.

Sigmodon hispidus berlandieri (Baird).

1855. *Sigmodon berlandieri* Baird, Proc. Acad. Nat. Sci. Phila., VII, p. 333. (Rio Nazas, Coahuila, Mex.)

Two specimens examined from Mesilla, Donna Ana county, N. M., and Pecos, Reeves county, Tex.

Neotoma micropus canescens Allen.

1891. *Neotoma micropus canescens* Allen, Bull. Amer. Mus. Nat. Hist., III, p. 285, June 30, 1891. (North Beaver creek, Panhandle of Oklahoma.)

A specimen from Pecos, Reeves county, Tex., differs considerably from a Brownsville, Tex., specimen, and agrees with a specimen from Fort Hancock, Tex., in the much paler coloration.

Neotoma mexicana Baird.

1855. *Neotoma mexicana* Baird, Proc. Acad. Nat Sci. Phila., VII, p. 333. (Mountains near Chihuahua, Mex.)

Seven specimens examined from the following localities: Ruidoso, Forks of Ruidoso and Hale's Ranch, Lincoln county, and Mescalero, Otero county, N. M.

Cratogeomys castanops (Baird).

1852. *Pseudostoma castanops* Baird, Rep. Stansbury's Exped. Great Salt Lake, p. 313, June, 1852. (Near Las Animas, Colo.)

Three specimens examined from Pecos, Reeves county, Tex.

Thomomys fulvus (Woodhouse).

1852. *Geomys fulvus* Woodhouse, Proc. Acad. Nat. Sci. Phila., VI, p. 201. (San Francisco Mountain, Ariz.)

Specimens of this form have been examined from Hale's Ranch, Lincoln county, and Las Vegas, San Miguel county, N. M., the latter collected by Emerson Atkins and submitted by Prof. Cockerell. One specimen from the latter locality is uniform plumbeous, except the feet and mouth, which are white.

Thomomys fossor Allen.

1893. *Thomomys fossor* Allen, Bull. Amer. Mus. Nat. Hist., V, p. 51, April 28, 1893. (Florida, La Plata county, Colo.)

One specimen of this species from Agua Fria Park, Colfax county, N. M., collected by Emerson Atkins, was submitted by Prof. Cockerell. It agrees with the type except for the more hirsute tail.

Dipodomys merriami ambiguus (Merriam).

1890. *Dipodomys ambiguus* Merriam, North American Fauna, No. 4, p. 42, October 8, 1890. (El Paso, Tex.)

A fine series of sixteen specimens of this form was collected in the vicinity of Alamogordo, Otero county, N. M., and a single specimen was also examined from Pecos, Reeves county, Tex. A considerable range of variation is presented in the series, some specimens appearing quite grayish in comparison to the usual pale buffy coloration.

Dipodomys spectabilis Merriam.

1890. *Dipodomys spectabilis* Merriam, North American Fauna, No. 4, p. 46. October 8, 1890. (Dos Cabezos, Ariz.)

A specimen of this form from vicinity of Alamogordo, Otero county, N. M., probably not quite mature, differs from topotypes from the Biological Survey collection in the slightly smaller size and more grayish coloration.

Perodipus ordii (Woodhouse).

1853. *Dipodomys ordii* Woodhouse, Proc. Acad. Nat. Sci. Phila., VI, p. 235. (El Paso, Tex.)

A specimen of this species was examined from Pecos, Reeves county, Tex.

Perognathus flavus Baird.

1855. *Perognathus flavus* Baird, Proc. Acad. Nat. Sci. Phila., VII, p. 332. (El Paso, Tex.)

Six specimens of this form from the vicinity of Alamogordo, Otero county, N. M., were examined.

Perognathus penicillatus eremicus (Mearns).

1898. *Perognathus (Chætodipus) eremicus* Mearns, Bull. Amer. Mus. Nat. Hist., X, p. 300, August 31, 1898. (Fort Hancock, Tex.)

Two specimens of this race were collected in the vicinity of Alamogordo, Otero county, N. M.

Perognathus hispidus paradoxus (Merriam).

1889. *Perognathus paradoxus* Merriam. North American Fauna, No. 1, p. 24. October 25, 1889. (Banner, Kan.)

Two specimens of this form were examined, one from Mesilla, Donna Ana county, and the other from Rio Gallinas, Las Vegas, San Miguel county, N. M., collected by Emerson Atkins and submitted by Prof. Cockerell.

Perognathus intermedius Merriam.

1889. *Perognathus intermedius* Merriam, North American Fauna, No. 1, p. 18, October 25, 1889. (Mud Spring, Ariz.)

The collection of the Academy contains a male from Mesilla, Donna Ana county, N. M.

Lepus arizonæ minor Mearns.

1896. *Lepus arizonæ minor* Mearns, Proc. U. S. Nat. Mus., XVIII, p. 557, June 24, 1896. (El Paso, Tex.)

Two specimens from Pecos, Reeves county, Tex., are referable to this form.

Lepus texianus griseus Mearns.

1896. *Lepus texianus griseus* Mearns, Proc. U. S. Nat. Mus., XVIII, p. 562, June 24, 1896. (Fort Hancock, Tex.)

An immature specimen from the vicinity of Alamogordo, Otero county, N. M., appears to belong here, but it is not developed enough for positive identification.

Putorius (Lutreola) vison (Schreber).

1778. *Mustela vison* Schreber, Säugthiere, III, p. 463. (Eastern Canada.)

A skin of a mink collected at Las Vegas, San Miguel county, N. M., by Marshall Robbins, was submitted by Prof. Cockerell. In the absence of the skull and strictly comparable material, the exact relationship to the various geographic races cannot be ascertained.

Myotis evotis (H. Allen).

1864. *Vespertilio evotis* H. Allen, Monogr. Bats N. Amer., p. 48, June, 1864. (Monterey, Cal.)

Two specimens of this species have been examined, one from Sapello Cañon, Las Vegas range, San Miguel county, N. M., taken at an altitude of 10,000 feet; the other from Dry Cañon, Sacramento Mountains, Otero county, N. M.

Nyctinomus mexicanus (Saussure).

1860. *M[olossus] mexicanus* Saussure, Revue et Magasin de Zoologie, 2e sér., XII, p. 283. (Plateau and higher mountains of Central Mexico,—Cofre de Perote (13,000 feet), Ameca and foot of Popocatepetl (8,500 feet) specified.

The name *mexicanus* is used provisionally for the *Nyctinomus* of central and western Texas and southern New Mexico. Further study may show that it is not identical with the central Mexican form, but as far as can be judged by Saussure's measurements, closer relationship exists with *mexicanus* than with *cynocephalus*. The latter form is a smaller animal, the average length of the forearm in five specimens from Tarpon Springs, Fla., being 40.1 mm., while five specimens from New Mexico and Texas average 42.7 mm. True *brasiliènsis* is, of course, a quite different animal. Specimens have been examined from Mesilla, Donna Ana county, N. M.; Pecos, Reeves county; Helotes, Bexar county, and San Diego, Duval county, Tex.

BIRDS.

The birds obtained number 122 specimens, representing thirty-one species, while ten others are added to the list which were seen but not secured. These latter are marked with an asterisk.

Under each species are given Mr. Rehn's field-notes relative to its distribution, abundance, etc.

***Querquedula discors** (Linn.).

"One observed in alkali stream, Laluz Cañon, April 18."

***Callipepla squamata** (Vig.).

"Several observed near the mouth of Dry Cañon, May 2 and 9."

Zenaidura macroura (Linn.).

"Observed frequently April 16 to May 19. In the open country it was most frequent about cultivated tracts, and in the cañons could almost always be looked for in the vicinity of water."

***Cathartes aura** (Linn.)?

"Seen on four occasions, April 18–29."

Dryobates scalaris bairdi (Malh.).

"Found frequently in Dry Cañon. It was comparatively wild, and showed a decided preference for a peculiar species of cactus."

Chordeiles acutipennis texensis (Lawr.).

"Found several times in the Larrea belt, and was apparently nesting between the greasewood and mesquite bushes. All those seen were flushed from the ground, but careful search failed to reveal the eggs. May 2 to May 17."

***Aëronautes melanoleucus** (Baird).

"Rather numerous in Dry Cañon. April 22 to May 20; usually noticed in the morning."

Trochilus alexandri Bourc. and Muls.

"Several times noticed in Dry Cañon, April 17 to May 19, and one female secured. A nest obtained was built upon a small bush growing horizontally from the perpendicular side of a small cañon, about ten feet from the bottom."

***Tyrannus verticalis** Say?

"Several birds apparently of this species were observed May 1 to 2, but were very wild and apparently migrants, as none were seen later."

Myiarchus cineracens (Lawr.).

"Observed almost continuously, April 18 to May 17, everywhere in the cañons and sometimes in the Larrea as well. Its favorite perch was the top of a spidery cactus or the head of a yucca."

Sayornis saya (Bonap.).

"April 22 to May 19. Rather numerous in the cañons, near water."

***Corvus corax sinuatus** (Wagl.).

"Several observed each morning, April 12 to 17, and again May 15. Seen also at Ysleta, Tex., April 4."

Corvus cryptoleucus Couch.

"One shot April 25, a mile and a half north of Alamogordo. It was feeding on the carcass of a cow."

Icterus parisorum Bonap.

"April 17 to May 16. Fairly numerous near the arroyos about the mouth of the cañons and in the lower foothills, and very shy."

***Scolecophagus cyanocephalus** (Wagl.).

"Several noticed in the town of Alamogordo, April 25 and May 22."

Carpodacus mexicanus frontalis (Say).

"Rather numerous through April, but not so common in May. Most frequent near the spring in Dry Cañon, where they could be seen at almost any time drinking from the film of water that trickled down the side of the cañon."

Astragalinus psaltria (Say).

"Seen with the preceding, April 7 to May 17." All the specimens are molting and, contrary to the custom in the Eastern *A. tristis*, the flight feathers are being renewed at the prenuptial molt.

Zonotrichia leucophrys (Forst.).

"Found both in the cañon and on the plain in the Larrea belt, always in small flocks, April 7 to April 29, and several on May 1."

Some of the males (one-year-old birds?) are in the prenuptial molt and are acquiring the black and white feathers of the crown. Other highly plumaged individuals, probably old birds, show no signs of molt.

Spizella breweri Cass.

"One secured April 15; and a number seen the next day in the Larrea."

Spizella atrigularis (Cab.).

One secured in Dry Cañon, May 17. This capture extends the range of the species some distance eastward, the Hachita Mountains being the previous limit of its distribution, so far as I can find in the records.

Amphispiza bilineata deserticola Ridgw.

"By far the most abundant and characteristic bird of the region, both on the plain and in the cañons. Observed continuously, April 7 to May 21. A nest with three eggs was found May 14, which was possibly a second clutch, as a fledgling was secured some days before."

Aimophila ruficeps scottii (Senn.).

"Seen several times in the cañons, April 11 to May 17."

Pipilo fuscus mesoleucus (Baird).

"Noticed only in the cañons and on the lower foothills, April 8 to 22."

Oreospiza chlorura (Aud.).

"Associated with the preceding. April 8 to 29."

Calamospiza melanocorys Stejn.

A number seen May 1 in the cañon. One male secured had nearly finished the molt, including the tertials, but not the rest of the flight feathers.

Piranga hepatica Swains.

A male obtained in the foothills, May 8.

***Petrochelidon lunifrons** (Say).

"Several observed May 19."

Hirundo erythrogastra Bodd.

"Observed several times, April 18, May 20 and 22."

***Tachycineta thalassina** (Swains.).

"April 7 to May 20; usually seen toward evening."

***Lanius ludovicianus excubitorides** (Swains.).

"Observed at Ysleta, Tex., April 2, and at Alamogordo, May 22."

Dendroica auduboni (Towns.).

One secured April 18, Laluz Cañon.

Helminthophila virginiæ (Baird).

One shot in Dry Cañon, April 29.

Wilsonia pusilla pileolata (Pall.).

Two obtained in Dry Cañon, April 24 and 29.

Mimus polyglottos leucopterus (Vig.).

"Abundant about the mouth of the cañon, May 8–21."

Toxostoma crissalis Henry.

"Very retiring in habits and always frequenting the mouth of the cañon, April 7 to May 16."

Heleodytes brunneicapillus couesi Mearns.

"Noticed in the foothills in small flocks, April 9."

The specimen secured seems to be unquestionably this form, although two from Pecos in the Academy's collection approach *anthonyi* somewhat in the broadening of the marks on the back.

Salpinctes obsoletus (Say).

"Noticed continuously, April 7 to May 21, in the cañons only."

Thryomanes bewickii leucogaster (Baird).

Two secured in Dry Cañon, April 25 and May 6.

Catherpes mexicanus conspersus Ridgw.

"Found in the deeper parts of the cañon, where the junipers begin and the greasewood stops, April 8 to May 17."

The wear on the plumage of the back of these birds causes a striking difference in their appearance. First the white borders to the spots are lost and then the spots themselves, leaving the back almost uniform and very different in appearance from the perfect postnuptial plumage.

Auriparus flaviceps (Sundev.).

"Noticed several times in the cañon, April 18 and May 9." A nest and set of eggs were secured.

Polioptila cærulea obscura Ridgw.

"Found almost entirely in the cañon, April 24 to May 13."

REPTILES.

Sixteen species of reptiles were obtained, many of them represented by good series of specimens. These are about equally divided between forms which range over the central Lower Sonoran area of Texas and those which are characteristic of the desert region of Arizona to the

westward, the valleys of southern New Mexico being respectively the western and eastern limit of range of the two groups.

Of the species which, according to Cope, range over the first plateau region of Texas (Lower Sonoran) may be mentioned:

Sceloporus torquatus poinsetti,	*Holbrookia texana,*
?*Sceloporus consobrinus,*	*Salvadora grahamiæ,*
Anota modesta,	*Crotalus adamanteus atrox,*
Phrynosoma cornutum,	*Crotalus confluentus.*

The species of the more western desert region are:

Cnemidophorus tessellatus,	*Crotaphytes wislizenii,*
?*Cnemidophorus gularis,*	*Uta stansburyiana,*
Sceloporus clarkii,	*Pityophis sayi bellona.*
Crotaphytes c. baileyi,	

Of course, the distribution of some of these species has not been worked out in sufficient detail to warrant positive statements as to their range, while a number of recorded localities are so obviously erroneous that we are forced to attribute them to confusion of labels, an accident which could easily happen in the early days of collecting. However, the geographic relationship of the species contained in the present collection would seem to be about as above.

To add to the value of the following list we have added notes on the species contained in a valuable collection from Pecos, Tex., recently presented to the Academy by Mr. Arthur Erwin Brown. This region being very similar in its faunal relations to the vicinity of Alamogordo, the comparison of the faunæ is of much interest.

Crotaphytes collaris baileyi (Stejn.).

Two specimens secured in Dry Cañon, May 10 and 13. Dr. Stejneger has divided the old *C. collaris* into two very closely related forms, *C. baileyi* of the western deserts and true *C. collaris* of the eastern region (Texas). In Prof. Cope's paper on the geographic position of Texas, he describes this species as ranging over what we now know as the Lower Sonoran area of that State, while according to Dr. Merriam *C. baileyi* in the western deserts is an Upper Sonoran form. It would be interesting to know the exact zonal relationship of the specimens described by Prof. Cope from western Texas and New Mexico, where he states that both forms occur together and exhibit all stages of intergradation, so far as arrangement of scales is concerned (*Crocodilians, Lizards and Snakes of North America*). A series of eleven specimens in Mr. A. E. Brown's collection

from Pecos represents both forms, so that at least *C. baileyi* must be regarded as a subspecies.

Crotaphytes wislizenii B. and G.

One obtained on the plain, May 6. This species is regarded by Dr. Merriam as typical of the Lower Sonoran, but also ranging a certain distance into the Upper Sonoran belt. It has been obtained in the vicinity of Pecos, Tex., but not farther east.

Uta stansburyana B. and G.

A large number secured in the country about Alamogordo show considerable variation in color, but the relationship of the species and its possible races is too involved for present consideration.

Holbrookia texana Troschel.

This species was common in Dry Cañon. It is a characteristic form of the Lower Sonoran of central Texas, and has been obtained by Prof. Cope as far west as Lake Valley, N. M., which seems to mark the western limit of its range. Mr. Brown's Pecos collection contains several of this species.

Sceloporus torquatus poinsettii B. and G.

One adult, May 10.

This is a common species in central Texas, and has been recorded by Cope from southeastern Arizona. Even if the localities on these specimens are correct, it would seem to be decidedly an eastern species.

Mr. Brown obtained one from the vicinity of Pecos, Tex.

Sceloporus clarkii B. and G.

One young individual secured near Alamogordo, May 24.

This form is closely related to *S. magister*, but according to Dr. Stejneger is restricted to southeastern Arizona (Upper Sonoran), while the latter is characteristic of the Lower Sonoran deserts north to Utah and Nevada. This specimen represents the farthest point east at which the species has been recorded, so far as I am aware, though Prof. Cockerell has sent one to the U. S. National Museum from Las Cruces, N. M. Four specimens are in Mr. Brown's Pecos collection.

Sceloporus consobrinus B. and G.

This lizard was common in Dry Cañon as well as on the desert. It is apparently the form so identified by Cope, but probably not the one so named by Stejneger in the report on reptiles collected on the San Francisco Mountain survey. One specimen from Highrolls, Sacramento Mountains, in the Transition belt, is doubtless referable to the latter. It is darker and more heavily built than those from the desert. The material in the Academy collection has not sufficiently accurate data as

to locality and altitude to properly work out this difficult group, so that the above identification must be taken as provisional. Found plentifully also at Pecos, Tex.

Phrynosoma cornutum Harlan.

Common on the plain all about Alamogordo; a typical species of the eastern Lower Sonoran region and extending well up the Rio Grande Valley in New Mexico.

Phrynosoma douglasii hernandesi Girard.

Obtained abundantly by Mr. Viereck in the Transition and Canadian belts of the Sacramento Mountains. Specimens were also secured for the Academy from Sapello Cañon, San Miguel county, N. M., in August, 1901, by Dr. Henry Skinner.

Mr. Viereck brought home a live individual of this species and kept it in captivity for some time. It proved to be an adult female, and gave birth to thirteen young. He gives me the following information relative to the operation: When first noticed four young had been born, a fifth appeared at 10.05 A.M., and after that one was deposited about every five minutes. The birth was effected by the female standing on her hind legs as high from the ground as possible. There first appeared a drop of clear fluid, followed by a bubble-like transparent membrane containing the young, which is then entirely discharged and dropped, the operation taking less than two minutes. If the young is perfect it will soon begin to wriggle, and will clear itself of the membrane in about five minutes from birth. The young are at first narrow and cylindrical, but as soon as they begin to inhale air they become broad and flat like the adult, and darken in color. They measured at birth 16 × 10 mm.

Some were evidently born prematurely and showed no signs of life; they were doubled up and surrounded by a glutinous mass.

Anota modesta (Girard).

Very common on the plains about Alamogordo. This is another species of the Lower Sonoran of central Texas, and a number are in Mr. Brown's collection from Pecos.

Cnemidophorus gularis B. and G.

Abundant in the cañons, but not found in the desert regions about Alamogordo, where its place is taken by the following species. To the westward the relative distribution of the two remains the same, *C. gularis* occupying the Upper Sonoran of Arizona east of Tucson, while *C. tessellatus* spreads over all the Lower Sonoran desert areas and, according to Dr. Merriam, pushes up some distance into the Upper Sonoran of the

Death Valley region. The exact relationship and distribution of these two forms and the eastern *C. sexlineatus* is a very difficult problem, though it would probably be much simplified by adequate material with exact data, such as that borne by the series before me. Many of the localities quoted by Prof. Cope in his *Crocodilians, Lizards and Snakes of N. A.* are so exceedingly vague and others so doubtful that they had better be ignored, at least until confirmed. After examining the material received by him from Texas, it would seem that *C. sexlineatus* extends over the Austro-riparian region of eastern Texas, departing but little from the normal type until we reach the border of the Lower Sonoran (first plateau) belt. Here we have a form closely resembling the *C. gularis* of Dry Cañon, which would seem to be the only form in central Texas. *C. grahami* Cope, of which I have examined specimens from the Staked Plains, seems to be most closely related to *C. tessellatus;* but if the central Texas form is *C. gularis*, we would have the faunal relation of the representatives of the two species exactly reversed as compared with the vicinity of Alamogordo, since the Staked Plains are Upper Sonoran, and central Texas Lower Sonoran.

The Academy has both species from the vicinity of Pecos, but without details of distribution; and as both faunal belts occur there in close proximity, it is quite possible that their distribution is as sharply limited as at Alamogordo. Mr. Brown's Pecos collection contains specimens of both *tessellatus* and *gularis*, as well as some identified as *sexlineatus*. They are accompanied by no data as to relative habitats.

Cnemidophorus tessellatus (Say).

Abundant in the desert about Alamogordo.

Pityophis sayi bellona B. and G.

A number of specimens obtained, which are probably referable to the western desert race. They possess a broad rostral, but have usually a well-indicated black, subcaudal, longitudinal stripe.

Salvadora grahamiæ B. and G.

One specimen obtained which belongs to the typical form. Several others were seen. Mr. Brown obtained one from Pecos, Texas.

Crotalus adamanteus atrox B. and G.

One specimen secured.

Crotalus confluentus Say.

One specimen which agrees exactly with Prof. Cope's type of *C. pulverulentus* from Lake Valley, N. M., but the characters do not seem to have any significance further than indicating individual variation.

The following additional species are contained in Mr. A. E. Brown's collection from Pecos, Tex.

Eumeces obsoletus B. and G.,
Uta ornata B. and G.,
Rhinochilus lecontei B. and G.,
Heterodon nasicus B. and G.,
Zamenis flagellum Shaw,
Zamenis tæniatus ornatus B. and G.,
Contia episcopa Kenn.,
Glaucona dulcis B. and G.,
Tantilla nigriceps Kenn.

BATRACHIANS.

The only Batrachian obtained was

Bufo punctatus B. and G.

Two individuals from the spring in Dry Cañon.

MYRIOPODS FROM BEULAH, NEW MEXICO.

BY RALPH V. CHAMBERLIN.

The chilopods and diplopods noted and described in this paper compose a small collection kindly sent me for determination by Prof. T. D. A. Cockerell, to whom I wish here to express my thanks. All were collected at Beulah, N. M., which is at an elevation of about 8,000 feet above sea-level and within the Canadian zone. The forms prove to be largely peculiar, each being easily distinguished from any previously described species. The *Geophilus* is especially interesting.

Lithobius glyptocephalus sp. nov.

Diagnosis.—Angles of the 9th, 11th and 13th dorsal plates produced; articles of antennæ 20; ocelli 16–18 in three series; prosternal teeth 6–6, 7–7; spines of first legs beneath 1, 3, 2, of penult 1, 3, 3, 2, of anal 1, 3, 3, 1; coxal pores 6, 7, 7, 7–6, 7, 8, 8, transverse; length 20 mm.

Description.—Body brown to light-brown, head and posterior dorsal scuta darker, reddish-brown or chestnut; venter paler; legs colored similarly to body, but distal joints, especially the first tarsal, purplish; antennæ chestnut proximally, the terminal portion light-brown; dorsal plates roughened, sparsely pilose, especially caudad; antennæ moderately pilose with stiff hairs.

Head subcordate, slightly wider than long (12:11.5); a strong furrow extending dorso-mesad on each side, each furrow dividing into two branches, the anterior of which curves forward to unite with its fellow of the opposite side just back of the frontal suture, the posterior branches uniting similarly in front of caudal margin of head.

Ocelli in a narrow elongate patch which is widest behind; 16–18 in number, arranged in three series (1 + 7, 6, 4–1 + 5, 5, 5); rather large and distinct.

Antennæ short, consisting of 20 articles of moderate length, the ultimate long and pointed at the end.

Prosternal teeth 6–6, 7–7, uniform.

Angles of the 9th, 11th and 13th dorsal plates produced; plates more or less distinctly depressed along the median longitudinal line; posterior margin of principal plates, except 7th, sinuate, posterior margin of 7th straight; principal plates strongly marginate laterally and posteriorly.

Spines of the first legs $\frac{0, 0, 3, 2\text{-}3, 1}{0, 0, 1, 3, 2}$; of the penult $\frac{1, 0, 3, 1, 1}{0, 1, 3, 3, 2}$, the claw with one spine; of the anal $\frac{1, 0, 3, 1, 0}{0, 1, 3, 3, 1}$, the claw unarmed; last two coxæ armed laterally with a stout spine.

Coxal pores 6, 7, 7, 6–6, 7, 8, 8, transversely elongate.

Gonopods of female with the claw tripartite, the lateral lobes much reduced, almost minute; básal spines 2–2, stout, clavately thickened distally.

Genital appendages of male short and wart-like, pilose.

Length of body 20 mm.; width of 10th plate 2.6 mm.; length of antennæ 8.1 mm.; of anal legs 8.2 mm.

Remarks.—The description is based upon two adult specimens, a male and a female. This species seems to be nearest *L. howei* Boll., from which, however, it may easily be separated by the characters assigned in the diagnosis.

Lithobius Beulæ sp. nov.

Diagnosis.—Angles of none of the dorsal plates produced; head but little wider than long (10.5:10); articles of antennæ 21; ocelli 9–11, in two series; prosternal teeth 2–2; spines of first legs beneath 0, 2, 1, of penult 1, 3, 3, 1, the claw armed with a single spine; posterior coxæ unarmed beneath or laterally; coxal pores 2, 3, 3, 3, round; length 8 mm.

Description.—Body, head and antennæ brown, legs paler; polished; dorsum uniformly sparsely pilose with short hairs, hairs of venter more scattered; head subglabrous; legs, prosternum and prehensorial feet sparsely pilose; antennæ proximally with but few hairs or subglabrous, distally rather densely pilose; genital and anal segments clothed below with long hairs.

Head cordiform, posterior border truncate; a little wider than long (10.5:10); posterior lateral borders depressed; impressed on posterior portion with two longitudinal diverging sulci, each with a tendency to split into two lines anteriorly.

Ocelli in a linear patch, 9–11 in number, arranged in two series (1+3, 5–1+4, 6).

Antennæ short, articles 21, mostly short, the ultimate long and cylindrical.

Prosternal teeth 2–2, pale, acute.

Principal dorsal plates all margined laterally and caudally; the lateral and posterior borders, especially in the anterior plates, depressed, the dorsum within border strongly arched, bisulcate; posterior borders of lesser plates all straight, of principal ones gently sinuate, none produced.

Spines of the first legs $\frac{0,\ 0,\ 1,\ 1(2),\ 1}{0,\ 0,\ 0,\ 2,\ 1}$; of the penult $\frac{1,\ 0,\ 2,\ 1,\ 1}{0,\ 1,\ 3,\ 3,\ 1}$, the claw armed with a single spine; posterior coxæ unarmed beneath or laterally.

Coxal pores round, 2, 3, 3, 3.

Genital appendages of male small, wart-like.

Length of body, 7–8 mm.; width of 10th dorsal plate, .76 mm.; length of antennæ, 2.3 mm.

Remarks.—The description is based upon two males, both of which have lost the anal legs. The general appearance is not unlike that of *L. utahensis* Chamb., from the mountains of Utah.

Geophilus atopodon sp. nov.

Diagnosis.—Frontal plate discrete, last ventral plate narrow; anal pores present, moderately large; pleural pores 10–16 adjacent to ventral and dorsal plates; coxæ of prehensorial feet each armed with a stout tooth, the tooth of claw truncate at end; pairs of legs 49–51 (♀), claw of anal legs long (♀); length, 25 mm.

Description.—Rather robust, very gradually attenuated cephalad, more abruptly caudad; color uniformly light-brown, the legs the same, the antennæ lighter distally. Dorsal plates smooth, sparsely pilose; legs very sparsely pilose; last seven articles of antennæ densely pilose with short hairs, the proximal ones more sparsely provided with long hairs; prosternum and coxæ of prehensorial feet finely punctate.

Antennæ short, the ultimate joint reduced distally, shorter than the two preceding taken together.

Cephalic plate much longer than wide (2.5:1.9), anterior and posterior margins nearly straight, the sides curving, wider in front than behind. Frontal plate discrete, the suture V-shaped in the middle with the point directed backward. Cephalic plate back of suture impressed with a strong suture near each lateral margin and with one each side of the median line; a median sulcus extending cephalad in the V-shaped opening of the suture. Prebasal plate concealed. Basal plate as a whole more than twice wider than long (9:4), exposed portion wider than long in the ratio 9:2.25.

Claws of prehensorial feet when closed scarcely reaching the end of the first antennal article; claw armed at base with a moderately stout, truncate tooth; coxa armed with a stout tooth which is somewhat longer than that of the claw; prosternum wider than long (12:10.5), less than twice the height of the coxa, unarmed.

Dorsal scuta not sulcate or with a few of the middle ones indistinctly bisulcate; anterior præscuta short, becoming long or very long in the posterior middle region, the last ones again short.

First anterior spiracle large, vertically oval, a few following of the same shape, others round, gradually decreasing in size from the first to the last.

Anterior ventral plates with a median sulcus, some of the middle ones with a median oval area marked off laterally by semi-lunar depressions. Ventral pores numerous, in more anterior plates arranged in a median depressed area, in first middle plates in a longitudinal median band and in a narrower band cephalad of posterior margin, further back covering nearly the entire surface, although in some more or less absent from a median area while densely covering the plate elsewhere.

First pair of legs shorter and much more slender than those succeeding, legs increasing in length from the first to the last. Anal legs with a long claw.

Pleuræ of last segment with 10–16 pores arranged mostly along the margin of the ventral plate or partly covered by the latter, a number (4–5) also adjacent or somewhat overlapped by the dorsal plate. Last ventral plate a little wider than long, about as wide as the one preceding.

Pairs of legs 49–51. Length, 25 mm.; greatest width, 1.2 mm; length of antennæ, 2 mm.; of anal legs, .9 mm.

Remarks.—The types are two adult females. They are not very closely related to any other known species.

Parajulus neomexicanus sp. nov.

Diagnosis.—First dorsal plate smooth, its sides not at all striate; other segments strongly striate below. Repugnatorial pores small, free from the transverse suture. Last dorsal plate blunt behind, not extending beyond anal valves. Pre-anal scale convexly rounded in front and behind, the curved margins meeting at an acute angle laterally. Anal valves marginate, rugose. Male: Mandibular stipes strongly produced below; the greatly enlarged first pair of legs not at all bent or hamate at end, not tuberculate; copulatory feet exposed, the anterior plate set obliquely, very wide, clavately enlarged upward, and produced backward above base posteriorly, the inner border bent inward or backward, indented below top, concealing middle and posterior piece from the front and side.

Description.—Slender, smooth and shining, glabrous. General color light-brown, transversely banded with dark-brown or blackish, a median dorsal line of same; a series of suboval light-colored spots along lower part of each side; toward dorsum within dark band of each segment a short row of light-colored, often confluent, blotches each crossed

by a network of fine dark lines; in each segment laterad of the dorsal line a short, light-colored transverse line; feet pale; first dorsal plate and vertex of head light-brown, covered with a network of fine dark-brown lines; a dark, blackish band between eyes, with within near middle two light lines diverging cephalad; a light spot mesad from the base of each antenna; clypeal region light-brown; antennæ dark.

Head at vertex with a shallow median sulcus. Antennæ in length about equaling the width of the body; pilose, the terminal articles densely so; articles long. Ocelli in a large triangular patch, about 50 in number, arranged in 8 series.

First dorsal plate smooth, not at all striate; other segments strongly striate beneath, above with numerous longitudinal wavy lines; anterior segments more strongly striate than the posterior. Posterior angle of the last dorsal plate rounded, blunt, but little produced, not extending beyond anal valves. Pre-anal scale convexly rounded in front and behind, indented in the middle behind, the two curved margins meeting at an acute angle on each side; with two long bristles, otherwise glabrous.

Anal valves glabrous, marginate; the elevate margins crossed by a series of transverse sulci; valves elsewhere roughened by numerous longitudinal rugæ.

Repugnatorial pores small, not touching transverse suture.

Legs rather short, not extending beyond sides of body, sparsely pilose, claw strong; last tarsal joint with a row of stout bristles (*pulvilli tarsales*) projecting outward on each side (♂).

Male: Stipes of mandibles strongly produced below; first pair of legs greatly enlarged, reaching anterior margin of gnathochilarium, nearly straight, not bent or at all hamate at end, very sparsely pilose, not tuberculate; coxæ of second pair of legs meeting within and produced forward into a narrow tongue-like process with a round or button-shaped appendage at end, at base of coxæ a median pit which continues forward along process as a shallow furrow; copulatory appendages exposed; anterior plate set somewhat obliquely , very wide, clavately enlarged upward, the outer or posterior border much produced backward above base, concealing other pieces from front and side, inner border indented below top, bent inward or backward, plate pilose with numerous long hairs outward from bent border and along a line below and parallel with upper margin; middle piece (as also outer one) shorter than the anterior, subtriangular in caudal aspect, acutely pointed, with fine, rather distantly placed teeth along sides which are not strongly bent or rolled, inner basal portion produced forward, a hamate process

in front of each; outer or posterior piece narrowed above, its top rounded and a little bent, bearing a long bristle, at base also one or several long bristles.

Segments 47–57. Length, 36 mm.; width, 1.9 mm.

Remarks.—The specimens studied include three adults, two males and a female, and several immature individuals. The measurements given are from the largest individual, a male.

Polydesmus sp.

Several young individuals of a species of this genus are in the collection. They are of the stage possessing only twelve segments, and thus too young for determination.

LIST OF THE POLYCYSTID GREGARINES OF THE UNITED STATES.

BY HOWARD CRAWLEY.

I.

The polycystid gregarines of the United States have as yet been but very little studied, and the list here given, which I believe to be complete, contains but twenty-eight species. Of these, six are also found in Europe and were first described from there. It is to Prof. Leidy that we owe the better part of our knowledge of the American forms. Ten species were described by him in accounts published in the *Proceedings* of the Academy and in the *Transactions of the American Philosophical Society* from 1848–1889. In addition to these, four more species are described and figured by Leidy in manuscript notes now in possession of the Academy, access to which I owe to the kindness of the Secretary, Dr. Nolan. Of the remaining eight forms, one was described by Porter, and seven were found by me in animals collected at Wyncote, Pa., and Raleigh, N. C., during the past year.

The four forms described in Leidy's manuscript, and the one by Porter, were not named. I have accordingly created new species for them which, with the seven that I discovered, makes twelve new species. Although the method of naming a gregarine after its host has been objected to by Schneider, it appears to me the most advisable, and it has accordingly been followed. Considerable difficulty was experienced, however, in determining to which genera these new species belong. The generic characters of gregarines are mostly those of the cysts and spores, and I was particularly unfortunate in failing to obtain these stages. In several cases it has been possible to judge, even without these criteria, what the correct genus is, and such forms have been placed where they probably belong without question. Where, however, there was considerable doubt, a question mark has been placed before the generic name.

II.

The following is a list of the Arthropoda found to contain gregarines, the first column giving the number of individuals examined, the second the number parasitized:

Julus and *Parajulus*	165	158
Polydesmus virginiensis	32	26
Fontaria sp.	2	2
Lysiopetalum lactarium	16	6
Spirobolus sp.	1	1
Lithobius forcipatus	13	4
Scolopocryptops sexspinosus	6	3
Scutigera forceps	4	3
Geophilus sp.	8	0
Elater sp.	8	1
Cucujid larva	5	2
Discœlus ovalis	2	2
Harpalus caliginosus	1	1
Dytiscus sp., larva	1	1

It is headed with *Julus* and *Parajulus*. These two genera of Diplopods are distinguished by characters of the mouth-parts and anterior feet, but they are much alike and the smaller species of *Parajulus* are but little larger than those of *Julus*. No attempt was made to distinguish between these two genera and much less between the various species, but such an attempt would have been of no especial utility, even if successful. They are to be found together, beneath logs, stones and leaves, and, as the list shows, they are almost invariably parasitized, the gregarine being *Stenophora juli*. It is possible to obtain these Diplopods at any season of the year, and so far as my observations go, the gregarines have no seasonal cycle, but all stages are met with at any time. Usually a given host contains a moderate number of gregarines, from twenty to forty, these ranging from the largest adults to the smallest intracellular stages. Frequently, however, only a very few parasites are found in a host, and in such cases they will be for the most part quite small. In none of the millipedes examined have I come across the cysts, nor, to my knowledge, the free spores.

In consideration of their gregarious habit, and their diet of rotten wood and vegetable fibre, it is easy to see why *Julus* and *Parajulus* are so persistently parasitized. It is also worthy of note that other animals having the same mode of life and generally found in the same places do not appear ever to contain gregarines. A case in point is that of the Isopoda, *Oniscus* and *Porcellio*. These are almost always found with *Julus* and *Parajulus*, and they doubtless frequently swallow the spores of *Stenophora*. The isopod intestine is, however, lined with chitin, and

the immunity is probably due to the inability of a gregarine sporozoite to get into the cells.

The 32 specimens of *Polydesmus* examined were some from Wyncote and some from Raleigh, N. C. *Polydesmus* is infected by two gregarines, *Gregarina polydesmivirginiensis* and *Amphoroides fontariæ*. Of these, both were present in 14 hosts, *G. polydesmivirginiensis* alone in five and *A. fontariæ* alone in seven. The Diplopods from one region were about as frequently parasitized as from the other, but *G. polydesmivirginiensis* was present oftener and in larger numbers in the animals from Wyncote than in those from Raleigh, while the reverse was true in the case of *A. fontariæ*. It is for this reason that the latter, although a frequent parasite of *Polydesmus*, has been named for *Fontaria*. Where two gregarines parasitize a given host, it is generally found that one occurs far more frequently than the other. The more frequent parasite is spoken of as the primary, the other as the secondary. Usually, also, the primary parasite of one host is the secondary of another. In Pennsylvania, where *Polydesmus* is common and *Fontaria* does not occur, the former, as stated above, is more often parasitized by *G. polydesmivirginiensis* than by *A. fontariæ*. In North Carolina, where *Fontaria* is common, the more usual parasite of *Polydesmus* is *A. fontariæ*. This gregarine, furthermore, was present in great numbers in the two individuals of *Fontaria* I was able to examine. It may therefore be concluded that *G. polydesmivirginiensis* is the primary of *Polydesmus*, while *A. fontariæ* is the primary of *Fontaria*.

In *Polydesmus*, *G. polydesmivirginiensis* was usually present in moderate numbers, from 20 to 50, although occasionally there were only a very few. On the other hand, *A. fontariæ* ran to extremes. Some millipedes would show only two or three gregarines, while in other cases they were present by the hundreds. There were only a few, however, in the animals taken at Wyncote.

Of sixteen specimens of *Lysiopetalum lactarium*, six were parasitized. Two gregarines occur, one a new species which I have named *Gregarina calverti*, the other apparently *Stenophora juli*. Both gregarines were present in two hosts, *G. calverti* alone in three and *S. juli* alone in one. Thus the former species was present five times and the latter three. *G. calverti* is therefore to be regarded as the primary parasite of *Lysiopetalum*.

This millipede is found under stones in much dryer places than *Julus*, *Parajulus* or *Polydesmus*, and it is somewhat solitary in habit. It is thus easy to see why only a comparatively small percentage of them is parasitized. *G. calverti* occurred in moderate numbers in all

cases, whereas *S. juli* was present in hundreds in one case and in only small numbers in the other two.

Echinomera hispida, the primary parasite of *Lithobius forcipatus,* was found only four times in thirteen hosts collected at Wyncote and Raleigh. In two of these cases, moreover, but a single gregarine was found. At Cambridge, Mass., where *Lithobius* is a much commoner animal, a larger percentage are parasitized and the gregarines are present in larger numbers. *Actinocephalus dujardini,* the secondary parasite of *Lithobius,* is very rare.

Scolopocryptops is parasitized by *Hoplorhynchus actinotus.* The gregarines occur in small numbers, from ten to twelve, in fifty per cent. of the Chilopods.

Of the five specimens of *Scutigera forceps,* four contained gregarines The species is *Trichorhynchus pulcher;* and never but a very few, from three to ten, are present.

It is not necessary to go over the balance of the list in detail. Attention may, however, be called to the fact that eight individuals of *Geophilus* were opened in vain.

III.

Gregarina blattarum Sieb.

Gregarina blattarum Siebold (1839), p. 57, Taf. 3, figs. 57–61.
Gregarina blattarum Frantzius (1848), p. 190, Taf. 7, fig. iii.
Gregarina blattarum Stein (1848), p. 182, Taf. 9, figs. 38, 39.
Gregarina blattæ-orientalis Leidy (1853), p. 239, Pl. 11, figs. 39–41.
Clepsidrina blattarum Schneider (1875), p. 580, Pl. 17, figs. 11, 12.
Clepsidrina blattarum Bütschli (1881), p. 384, Taf. 20, 21
Clepsidrina blattarum Wolters (1891), p. 115, Taf. 7.
Clepsidrina blattarum Marshall (1893), p. 25, Taf. 20, 21.

Common in *Periplaneta orientalis, Periplaneta americana* and *Ectobia* (*Blatta*) *germanica.* A few specimens of *Ischnoptera pennsylvanicus,* the field cockroach, were examined, but none contained gregarines.

? Gregarina termitis Leidy.

Gregarina termitis Leidy (1881), p. 441, fig. 27.
Gregarina termitis Porter (1897), p. 65, Pl. 6, figs. 73–76.

Leidy says: "A small gregarine was once noticed in our Termite, and is represented in fig. 27. The body is ovoid, with the narrower end posterior. The head [protomerite] spheroid, compressed from above downward. Length .06 mm.; head .018 mm. long, .03 broad; body .036 mm. broad."

Porter adds the information that the gregarines are very common in some specimens of termites, occurring mostly in the anterior part of the small intestine, and that the nucleus contains one karyosome.

I have opened perhaps a dozen termites in a search for this parasite, but have not yet encountered it.

Gregarina achetæabbreviatæ Leidy. Pl. III, figs. 34-35.

Gregarina achetæabbreviatæ Leidy (1853), p. 238, Pl. 11, figs 33, 34.

Epimerite: Simple, spherical.

Protomerite: Somewhat pentagonal to hemispherical. Separated from the deutomerite by a sharp constriction. Shape modified in the associations.

Deutomerite: Cylindri cal, tapering slightly. Terminating bluntly.

Epicyte: Thick.

Sarcocyte: ?.

Entocyte: Of equal density in both protomerite and deutomerite.

Nucleus: Large, spherical with several karyosomes.

Dimensions: Maximum length 600 microns.

Host: Acheta abbreviata. Infection extensive.

Locality: Beach Haven, N. J.

?**Gregarina scarabeirelicti** Leidy.

Gregarina scarabeirelicti Leidy (1851), p. 208, 287.
Gregarina scarabeirelicti Leidy (1856), p. 47.

I have not seen this species.

?**Gregarina melolonthæbrunneæ** Leidy.

Gregarina melolonthæbrunneæ Leidy (1856), p. 47.

I have not seen this species.

Gregarina passalicornuti Leidy. Pl. II, fig. 24.

Gregarina passalicornuti Leidy (1853), p. 238, Pl. 11, figs. 30-31.

Epimerite: ?.

Protomerite: Hemispherical in the primites; considerably compressed in the satellites.

Deutomerite: Cylindrical; sometimes slightly narrower about the middle.

Epicyte: Thick.

Sarcocyte: Thick.

Entocyte: Opaque.

Nucleus: Moderate. Spherical.

Dimensions: Average length of pairs 350–400 microns.

Host: Passalus cornutus.

?**Gregarina polydesmivirginiensis** Leidy. Pl. II, fig. 25.

Gregarina polydesmivirginiensis Leidy (1853), p. 238, Pl. 10, figs. 23-29.

Epimerite: Not seen.

Protomerite: Always small; sometimes apparently undeveloped in

the younger animals. Never any constriction between it and the deutomerite in relaxed animals.

Deutomerite: Long. Anterior half usually much broader than posterior half. Usually considerably curved.

Epicyte: Very distinct. 1½–2 microns thick.

Sarcocyte: Distinct.

Entocyte: Usually, but not always, considerably denser in the anterior part of the deutomerite than in the posterior part.

Nucleus: Always with one karyosome.

Dimensions: 400 microns long.

Movements: This is a very active gregarine, and displays continually both changes of shape and progression. The contractions are generally confined to the anterior part of the deutomerite. As a rule, the smaller animals are less active than the larger.

Host: Polydesmus virginiensis. Infection is common, the parasites being present in moderate numbers.

Locality: Wyncote, Pa., and Raleigh, N. C.

? Gregarina elateræ sp. n. Pl. ?, fig. 11.

Epimerite: Spherical, with a granular contents. Usual size and appearance shown by fig. 11. In several cases, however, apparently on account of the absorption of water, it had increased enormously in size, so that its diameter exceeded the length of the gregarine.

Protomerite: Elliptical in outline, with the greater axis transverse. Posterior limit straight. Separated from the deutomerite by a sharp constriction.

Deutomerite: Oval to subspherical.

Epicyte: Very thin.

Sarcocyte: ?.

Entocyte: Granular in all three segments. Sparsely filled with large and very distinct granules, so that the appearance presented was rather that of a ciliate or a heliozoan packed with plant spores than a gregarine.

Nucleus: Not seen.

Dimensions: Maximum length 62 microns.

Movements: The animals were very sluggish, the only movements seen being an occasional lateral displacement of the protomerite, and, in one case, progression of perhaps one-half the animal's length.

Host: The larva of a large species of *Elater*. Infection only occasional, and never but a few gregarines present.

Locality: Wyncote, Pa.

? Gregarina discœli sp. n. Pl. I, figs. 7-10.

Epimerite: ?.

Protomerite: Helmet-shaped to pentagonal. Separated from the deutomerite by a shallow constriction in the adults, by a deep constriction in the young.

Deutomerite: Greatly elongated, cylindrical to slightly conical, terminating bluntly.

Epicyte: Very thin. Longitudinal striations not evident.

Sarcocyte: Apparently wanting.

Endocyte: Densely granular and opaque in the deutomerite; nearly transparent in the protomerite. Anterior part of protomerite free from granules.

Nucleus: Not readily seen, but apparently possessed of a number of karyosomes disposed in a cluster.

Dimensions: Maximum length 1200 microns. In the young the ratio of length to breadth is about eight to one, in the adults about fifteen to one.

Movements: These gregarines possess the flexibility of an eel. They frequently bent themselves into crescents, circles and short, close spirals, this last phenomenon demonstrating the spirality of the myocyte. Fig. 10 shows the longitudinal axis of one contorted animal observed, A being the anterior and P the posterior end.

Host: Discœlus ovalis. Of the two beetles examined, one contained from 50–75 parasites; the other not nearly so many.

Locality: Wyncote, Pa.

No cases of association were seen, but for the most part these gregarines were disposed in dense bunches with their posterior ends glued together. There was one such mass seen which presented the appearance of a bunch of celery, the animals being all closely apposed from their posterior ends nearly as far forward as their protomerites.

? Gregarina xylopini sp. n.[1] Pl. III, figs. 29, 30.

The two gregarines shown in figs. 29 and 30 are stated by Leidy to be parasites of the beetle *Xylopinus saperdoides*. Of the six beetles examined, five contained gregarines of the form shown in fig. 29, one of the form shown in fig. 30. These two forms are so dissimilar that it appears better, at present, to give only the figures, reserving the description until additional information is at hand.

? Gregarina boletophagi sp. n.[2] Pl. II, figs. 26-28.

Epimerite: ?.

Protomerite: Large, variable in shape. Separated from deutomerite by a sharp constriction.

[1] From Leidy's MSS. [2] From Leidy's MSS.

Deutomerite: Cylindrical, with a protrusion at the posterior end, to conical with a pointed end.

Epicyte: Thick.

Sarcocyte: ?.

Entocyte: Dense, uniform in both protomerite and deutomerite.

Nucleus: Moderate; oval to spherical, with one karyosome.

Dimensions: 320 microns long.

Host: *Boletophagus cornutus*.

Locality: Swarthmore, Pa.

? Gregarina calverti[3] sp. n. Pl. II, figs. 19–21.

Epimerite: Not seen.

Protomerite: Greatly compressed in the large animals (figs. 19, 20). Anterior boundary usually straight or slightly convex, but frequently concave, giving the protomerite the form of a shallow cup. Approximately reniform in the young animals (fig. 21). Constriction always deep and sharp.

Deutomerite: Displays a shoulder at the anterior end, being here widest. Narrows gradually backward, more regularly in the younger, less regularly in the older animals. Posterior end always blunt.

Epicyte: Thicker than the sarcocyte. Longitudinal sculpturing may or may not be present. It was often possible to see that the protomerite was longitudinally striated, but the cause for this appearance seemed to lie deeper than the epicyte.

Sarcocyte: Thinner than the epicyte.

Myocyte: Easily seen in the living animals.

Entocyte: In large animals black in transmitted light in the deutomerite and nearly so in the protomerite. In most cases, however, the granules do not fill the entire entocyte, but thin out rapidly toward the posterior end, so that in the last fourth or fifth of the entocyte they constitute only a narrow, central strip. This condition is shown in fig. 21, from a young animal, and is held true for nearly all the gregarines seen.

Nucleus: Not large, spherical, with one spherical karyosome.

Movements: These gregarines, although quite flexible, are rather sluggish, and usually lie motionless. Progression, when observed, was generally accompanied by lateral movements of the protomerite. As a rule, the animals were slightly curved, a phenomenon frequently displayed by elongated gregarines.

Dimensions: Maximum length 1,500 microns.

Host: *Lysiopetalum lactarium*.

Locality: Wyncote, Pa.

[3] To Philip P. Calvert.

Gregarina harpali sp. n. Pl. I, figs. 1-4.

Epimerite: Not seen.

Protomerite: In the adults (fig. 1) hemispherical and narrower than the deutomerite, from which it is separated by a sharp, but not extensive, constriction. In the young (figs. 2 and 3) knob-shaped, wider than the deutomerite and separated from that part by a shallow constriction.

Deutomerite: Conical in the adults to cylindrical in the young. The posterior end is normally blunt and rounded. These gregarines, however, are quite polymorphic and readily change shape.

Epicyte: Relatively very thin in the adults. Marked with very fine longitudinal ridges, which are not visible in the living animals and require sections for their demonstration.

Sarcocyte: Not visible in adults. In the young (fig. 3) present in the protomerite and constituting the thick septum. Apparently wanting in the rest of the deutomerite. In the front part of the protomerite a little papilla is present, apparently composed of a differentiation of the sarcocyte. This papilla is much more evident in some specimens than in others, and sometimes takes the form of a minute knob. It was never seen in adult animals.

Entocyte: Black in transmitted light in the adults, semi-transparent in the young, but in both as dense in the protomerite as in the deutomerite. In the young, as shown in fig. 3, there is a crescentic area almost free from granules. In stained and sectioned animals (fig. 4) this crescentic area is seen to consist of very dense cytoplasm, with a considerable affinity for stains. This condition is wholly lost in the adults.

Nucleus: In the living animals, wholly invisible in the adults and not satisfactorily to be made out in the young. Sectioned material shows that it is large, spherical, and possesses several karyosomes. These are variable in size and are scattered singly throughout the entire extent of the nucleus. They display the usual phenomenon of vacuoles.

Movements: The movements displayed by these gregarines were leisurely muscular contractions and slow progression. There was also a disposition to rumple the edges of the body, so that the epicyte of the deutomerite presented a series of scallops. These scallops underwent slow changes, the movement being doubtless the usual peristalsis, although very much slower than in the case of most gregarines. Progression was in either more or less of a straight line, or in curves of short radius. In the latter case, the animals held their bodies so bent that the longitudinal axis formed a curve. In all cases progression was

extremely slow. A number of animals showed no movement whatever and some of these held the scalloped outline without change.

Dimensions: Length 225–700 microns.

Host: Harpalus caliginosus. The gregarines were present in the intestine of the one beetle examined in hundreds, and while no associations were seen, there was a very marked tendency for them to be lying massed closely together.

Locality: Wyncote, Pa.

?**Hirmocystis ovalis** sp. n. Pl. I, figs. 5–6.

Epimerite: Usually elliptical in outline, with the longer axis transverse, but frequently considerably flattened down. Wall with double contour. Contents hyaline.

Protomerite: Hemispherical.

Deutomerite: Cylindrical to oval, but more usually the latter. Always terminating bluntly.

Epicyte: Thin over the anterior part of the protomerite; elsewhere thick. Longitudinal striations not seen.

Sarcocyte: ?.

Entocyte: Dark brown in the larger individuals, and of approximately the same density in both protomerite and deutomerite. The anterior third of the protomerite is usually, but not always, free from granules.

Nucleus: Not seen.

Dimensions: Greatest length 70 microns.

Host: The larva of a beetle doubtfully identified as belonging to the Cucujidæ. The gregarines occurred sparingly, ten or twelve being the greatest number found in any one host. About half the insects examined were parasitized.

?**Euspora lucani** sp. n.[4] Pl. III, fig. 38.

Epimerite: ?.

Protomerite: Small, compressed from before backward. Separated from the deutomerite by a deep constriction.

Deutomerite: Cylindrical; sometimes narrower in the middle.

Epicyte: Thick.

Sarcocyte: ?.

Entocyte: ?.

Nucleus: ?.

Dimensions: Of one association; primite 520×128 microns, satellite 360×108 microns.

[4] From Leidy's MSS.

Host: Lucanus dama.

Locality: Swarthmore, Pa.

The gregarines occurred either singly or associated in pairs.

Stenophora juli Frantzius.

Gregarina juli Frantzius (1848), p. 194, Taf. 7, fig. x, 1–2.
Gregarina larvata Leidy (1848–49), p. 232.
Gregarina juli-marginati Leidy (1853), p. 237, Pl. 10, figs. 1–20.
Gregarina juli-pusulli Leidy (1853), p. 238, Pl. 10, figs. 21–22.
Stenocephalus juli Schneider (1875), p. 584, Pl. 20, figs. 29–33.

The best figures extant of this gregarine are those published by Leidy in 1853. His fig. 17 is especially good in showing the apparent orifice through the thickened epicyte of the anterior part of the protomerite. The contortions displayed by the gregarine are also portrayed in an admirable manner.

This species lives in the intestine of *Julus* and the smaller species of *Parajulus*. It is extremely common, occurring in at least 90 per cent. of the hosts examined, usually in moderate numbers, from forty to fifty or thereabouts, but frequently only a very few are present. All stages from the smallest intracellular forms to the largest sporonts, may be found at any season of the year, but cysts are very rarely seen.

Stenophora juli continues as a cell parasite until it has reached a length of perhaps 100 microns. The cephalont stage is probably omitted. Leidy gives the maximum size as one-thirtieth of an inch, which is nearly a millimeter, but I have never seen the species longer than 400 microns.

Stenophora spiroboli sp. n. Pl. II, fig. 22.

Epimerite: Not seen.

Protomerite: Very small, narrower than the deutomerite and much compressed from before backward.

Deutomerite: Cylindrical, tapering but very little and terminating bluntly.

Epicyte: Very distinct; about 1½ microns thick. Longitudinal striations easily seen.

Sarcocyte: Well developed; about 2 microns thick over most of the animal, but attaining twice this thickness at the posterior end.

Entocyte: Opaque in both protomerite and deutomerite.

Nucleus: Not seen.

Dimensions: Maximum length 1,000 microns.

Movements: While progression was slight, the animals showed constant muscular movements. In some cases they bent themselves into the shape of the letter U, in others merely the anterior end was bent

over, but the one condition passed into the other. In addition, the anterior end was constantly being wrinkled and distorted, and little pseudopodia-like processes were protruded and withdrawn.

Host: Spirobolus. But one individual examined, which contained seven or eight gregarines, none less than 500 microns in length.

Locality: Raleigh, N. C.

Echinomera hispida Aimé Schn.

Echinocephalus hispidus Schneider (1875), p. 593, Pl. 16, figs. 36–40.

This gregarine was found in four out of thirteen individuals of *Lithobius forcipatus* collected at Wyncote, Pa., and Raleigh, N. C., but it is much commoner at Cambridge, Mass.

Echinomera microcephala Leidy.

Gregarina microcephala Leidy (1889), p. 11, 1 fig.

Our knowledge of this form rests upon a very short description given by Prof. Leidy. It is very much like *Echinomera hispida*, and is accordingly placed in that genus, but retained as a distinct species.

The total length is 350 microns; greatest width 100 microns. The protomerite is 12 microns long by 40 microns wide.

Host: Hoplocephala bicornis.

Trichorhynchus pulcher Aimé Schn.

Trichorhynchus pulcher Schneider (1882), p. 438, Pl. 13, fig. 14.
Gregarina megacephala Leidy (1889), p. 11, 1 fig.

This form is well described by Aimé Schneider, whose figure also is excellent, giving a very accurate idea of the actual animal. Schneider, however, gives no dimensions, while Leidy says that the dimensions vary from 420–750 microns, these figures agreeing very closely with those which I obtained.

My own observations on this species show it to be an active, very polymorphic gregarine, with the ability to undergo extensive alterations in shape. Thus, the anterior end of the protomerite, normally a blunt curve, frequently protrudes in a long tongue-shaped process. The peristaltic movement, so frequently displayed by gregarines, may, in this species, pass forward as well as backward. This indicates that here the contractile elements are capable of operating as well in one direction as another, which is certainly not the case in most polycystid gregarines.

Fusion, preparatory to encystment, was seen to take place "head to head."

Amphoroides fontariæ sp. n. Pl. I, figs. 12–14.

Epimerite: Not seen.

Protomerite: More or less pentagonal in outline. Separated from deutomerite by an evident constriction.

Deutomerite: Variable, normally a long oval. Sometimes shows a distinct shoulder in front. Always terminates bluntly.

Epicyte: Very distinct over the entire animal. Greatly thickened at the anterior part of the protomerite, this feature being as well marked in the smallest as in the largest animals. Longitudinal striations not evident.

Sarcocyte: Always present, but much more evident in some animals than in others.

Entocyte: Very opaque in the deutomerite, and nearly transparent in the protomerite, the contrast between the two parts being very sharp in this gregarine.

Nucleus: Moderate in size, spherical, with one usually spherical karyosome. Not always evident in the living animals.

Dimensions: Maximum length 135 microns.

Movements: This gregarine is very active, displaying constantly both muscular contractions and a gliding progression. The muscular activity manifests itself in lateral displacements of the protomerite, in bendings of the deutomerite and in a peristalsis which involves the anterior part of the deutomerite. Progression is easy and rapid and always accompanied by evidences of muscular contraction.

Hosts: Polydesmus and *Fontaria,* Diplopods of the family Polydesmidæ. The gregarines were usually present in hundreds in the parasitized animal, but often only a very few could be found.

Localities: Wyncote, Pa., and Raleigh, N. C.

Asterophora philica Leidy. Pl. III, figs. 31–33.

Gregarina philica Leidy (1889), p. 9, 1 fig.

It is impossible to give a description of this species. Figs. 31 and 32 are very plainly of the same gregarine, whereas fig. 33 seems almost certainly to belong to a different species. Further, the form figured by Leidy in 1889 is not so closely like that shown by figs. 31 and 32 as to render it certain that the two are the same.

I therefore include the three different forms under the same name, giving only the figures and reference, until such time as sufficient material is obtained to determine accurately what the actual facts may be.

The gregarines figured were about 300 microns long.

Asterophora cratoparis sp. n.[5] Pl. II, fig. 23.

Epimerite: Small; consists of a number of ribs projecting from a central knob.

Protomerite: Nearly reniform, but with a conical projection in front, upon which rests the epimerite. Separated from the deutomerite by a sharp constriction.

Deutomerite: Lanceolate; terminating bluntly.

Epicyte: Thick.

Sarcocyte: ?.

Entocyte: ?.

Nucleus: Not small; spherical, with a spherical karyosome.

Dimensions: Length 540 microns.

Host: Cratoparis lunatus, a beetle of the family Curculionidæ. Eight gregarines, all attached to the wall of the host's intestine, were present in the one individual examined.

Locality: Swarthmore, Pa.

Stephanophora locustæcarolinæ Leidy.

Gregarina locustæcarolinæ Leidy (1853), p. 239, Pl. 11, figs. 35–38.

Provisionally placed in the genus *Stephanophora* on account of the character of the epimerite. I have not yet encountered the species.

Bothriopsis histrio Aimé Schn. Pl. II, figs. 15–18.

Bothriopsis histrio Schneider (1875), p. 596, Pl. 21, figs. 8–13.
Bothriopsis histrio Léger (1892), p. 136, Pl. 13, figs. 1–3.

This gregarine was described by Aimé Schneider in 1875. The diagnosis then given is as follows: Epimerite wanting. Protomerite forming a large rounded mass, of which the anterior part may be either very convex or quite concave. Deutomerite oval. Septum projecting forward in such a fashion that it resembles the finger of a glove. Nucleus elliptical in outline, with several karyosomes. Epicyte with double contour, sarcocyte wanting and entocyte very finely granular. Animal highly polymorphic and movements very rapid.

Hosts: Hydaticus cinereus (larva), *Colymbetes fuscus* and *Acilius sulcatus.*

Léger adds the information that the epimerite consists of a number of long filaments.

I find what is apparently the same gregarine in the larva of *Dytiscus* sp., but four or five imagines were opened in vain. My observations, however, differ somewhat from Schneider's, although they do not appear to warrant creating a new species.

Fig. 15 shows the protomerite of this gregarine. As stated by Schnei-

[5] From Leidy's MSS.

der, it is a large rounded mass; but whereas Schneider's figures represent it to be solid, I find that it contains, at least in some cases, a large cavity. Within this cavity was a fluid in which floated a few granules.

This condition was the more usual, and free gregarines, as they moved about on the slide, presented a remarkable appearance with their enormous balloon-shaped protomerites. The appearance of other individuals was, however, markedly different. Fig. 17 shows an attached animal. Here the protomerite was narrow and elongated, the narrow anterior end being, so far as I was able to see, embedded in the cells of the host. In this case there were no indications of a cavity within the protomerite.

It is to be observed, in figs. 15, 17 and 18, that the septum dips backward. In a number of cases, however, the septum dipped forward, and such appears to have been the only condition seen by Schneider. In these gregarines, accordingly, the septum may dip in either direction, which indicates a high degree of flexibility and elasticity on the part of the sarcocyte, and this condition is also suggested by their superlative polymorphism.

It is therefore possible to interpret the rather curious appearance shown in fig. 16. This was drawn from a progressing individual, to all appearances wholly normal. In this animal, the protomerite lies embedded within the deutomerite. It may be suggested that this is derived from the condition shown in fig. 18 by a mere contraction of the most anterior part of the deutomerite, by which the protomerite is forced backward. Quite a number of animals presented this appearance.

Fig. 18 is from a permanent mount, and probably represents the normal form of the protomerite when only a small quantity of fluid is present. It is noteworthy in that the protomerite is more densely granular than the deutomerite.

The larger, more elongated specimens reached a length of 425 microns. There were about 25 gregarines in the beetle-larva, which was taken at Wyncote, Pa.

Actinocephalus dujardini Aimé Schn.

Actinocephalus dujardini Schneider (1875), p. 589, Pl. 16, figs. 9–20.

I have seen this little gregarine several times in specimens of *Lithobius forcipatus*.

Hoplorhynchus actinotus Leidy. Pl. III, figs. 36, 37.

Gregarina actinotus Leidy (1889), p. 10, 1 fig.

Epimerite: Amphora-shaped. Differentiated in front into four

dichotomously branched lobes. Contents hyaline. Easily detached. In the small animals, making up nearly one-half the total length; in the adults, from one-fourth to one-fifth of the total length.

Protomerite: In the young, knob-shaped, with the transverse and longitudinal diameters about equal. In the adults, hemispherical, with the transverse diameter twice as great as the longitudinal.

Deutomerite: Conical, with a pointed posterior end. Usually a shoulder at the septum. Subject to considerable alterations in shape, being at one time longer and narrower, at another shorter and broader.

Epicyte: About 3 microns thick in the larger individuals. Longitudinal striations could not be made out.

Sarcocyte: ?.

Entocyte: Absolutely opaque in the larger animals. Much more nearly transparent in the smaller.

Nucleus: Only apparent as a light oval area, usually lying diagonally across the deutomerite.

Dimensions: The largest sporont seen was 485 microns long by 105 microns broad. Leidy gives 600 microns for the length of a cephalont.

Host: Scolopocryptops. Not rare. Infection usually moderate, from 15–30 parasites per host.

Locality: Wyncote, Pa., Raleigh, N. C., and Wallingford, Pa.

Apparently, in this gregarine, the septum tends to disappear. It is much more evident in some cephalonts than in others, and in one sporont seen no septum could be made out, and the entocyte of the protomerite was not distinguishable from that of the deutomerite.

Doliocystis rhyncoboli sp. n.

—— —— Porter (1897*a*), p. 8, Pl. 3, figs. 37–53.

This form is described, but not named, by Porter, and the figures given are scarcely diagnostic enough to determine the correct genus. Its habitat, the intestine of the marine worm *Rhyncobolus americanus* Verrill, renders it probable, however, that the parasite belongs to the genus *Doliocystis*, and the specific name *rhyncoboli* may appropriately be used.

Porter describes it as a tricystid, but says: "The conical base of the epimerite is continuous with the contents of the anterior portion of the protomerite, for there is an orifice through the cuticular wall of the protomerite, and the base of the epimerite is composed of protoplasm very similar to that of the protomerite."

But such an intimate union between the protoplasmic parts of protomerite and epimerite is not known to exist in gregarines. It may therefore be suggested that that part of the animal which Porter took to

be protomerite plus epimerite was in reality only the epimerite, and that the gregarine is truly a dicystid.

The deutomerite is described as being composed of very loose and highly vacuolated protoplasm, and the nucleus as showing several karyosomes. The animal is 700 microns long.

The host is *Rhyncobolus americanus* Verrill. The parasite occurs in one worm in ten, and rarely more than eight were found in any one host.

Porter makes the suggestion that gregarine locomotion "is probably caused by a very slight undulatory motion of the under side of the animal." I regret having been unaware of this suggestion, which accords with my own opinions, at the time I wrote my article on gregarine progression.

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Explanation of Plates I, II and III.

Plate I, Fig. 1.—*Gregarina harpali* (p. 49). Adult.

Fig. 2.—*Gregarina harpali* (p. 49). Young.
Fig. 3.—*Gregarina harpali* (p. 49). Protomerite of a young animal.
Fig. 4.—*Gregarina harpali* (p. 49). Section of the protomerite of a young animal.
Fig. 5.—*Hirmocystis ovalis* (p. 50). Sporont.
Fig. 6.—*Hirmocystis ovalis* (p. 50). Cephalont.
Fig. 7.—*Gregarina discœli* (p. 47). Adult.
Fig. 8.—*Gregarina discœli* (p. 47). Young.
Fig. 9.—*Gregarina discœli* (p. 47). Protomerite of an adult animal.
Fig. 10.—*Gregarina discœli* (p. 47). Diagram showing the longitudinal axis of a contorted animal, A being the anterior and P the posterior end.
Fig. 11.—*Gregarina elateræ* (p. 46). Cephalont.
Figs. 12–14.—*Amphoroides fontariæ* (p. 53). Adults.

Plate II, Figs. 15–18.—*Bothriopsis histrio* (p. 54).

Fig. 19.—*Gregarina calverti* (p. 48). Adult.
Fig. 20.—*Gregarina calverti* (p. 48). Protomerite of an adult.
Fig. 21.—*Gregarina calverti* (p. 48). Young
Fig. 22.—*Stenophora spiroboli* (p. 51). Adult.
Fig. 23.—*Asterophora cratoparis* (p. 54). Cephalont. (Copied from Leidy's MSS.)
Fig. 24.—*Gregarina passalicornuti* (p. 45). Association. (Copied from Leidy's MSS.)
Fig. 25.—*Gregarina polydesmivirginiensis* (p. 45). Adult. (Copied from Leidy's MSS.)
Figs. 26–28.—*Gregarina boletophagi* (p. 47). (Copied from Leidy's MSS.)

Plate III, Figs. 29, 30.—*Gregarina xylopini* (p. 47). (Copied from Leidy's MSS.)

Figs. 31–33.—*Asterophora philica* (p. 53). (Copied from Leidy's MSS).
Figs. 34, 35.—*Gregarina achetæabbreviatæ* (p. 45). (Copied from Leidy's MSS.)
Figs. 36–37.—*Hoplorynchus actinotus* (p. 55). Cephalonts. (Copied from Leidy's MMS.)
Fig. 38.—*Euspora lucani* (p. 50). Association. (Copied from Leidy's MMS.)

STUDIES ON THE HABITS OF SPIDERS, PARTICULARLY THOSE OF THE MATING PERIOD.[1]

BY THOMAS H. MONTGOMERY, JR.,[1] PH.D.

It is remarkable how little the habits of spiders have been pursued, in consideration of the fact of their many peculiarities. Their webs and the making of them have received the most attention, and next to that their architecture of nests and burrows. A great literature has grown up about the subject of the "threads of the Virgin," as to the use of spiders in medicine, and as to their supposed venomous bites. On the subject of generation, where the spiders are especially removed from other animals, for the most part only scattered and brief observations are to be found, and these mainly among the older observers. Menge, who saw and described more of the mating habits than any other naturalist before or since, took the pains to watch each of his specimens alive in a bottle before killing it, and this was the simple secret of his success. Most of the other recorded facts of mating, except the notable ones of de Lignac, Bertkau and the Peckhams, were gleaned from chance observation in the field, which must be necessarily less full and precise. Let the arachnologist watch his spiders in the life before he kills them to describe their carcasses, and the facts of structure will have a richer and more inspiring influence.

And of further interest is the consideration that spiders were first classified according to a certain set of habits, namely, the architecture of their webs, and some of the groups thus early defined are still rectified by morphological characters. In them is to be found a good opportunity for examining the conservatism of habit, and for testing how much reliance in taxonomy may be placed upon similarities of habit—similarities that may persist through great changes of structure.

The present study concerns mainly the processes of courtship and copulation, the remarkable filling of the palpi with sperm (for which the term "sperm-induction" is here introduced), the process of cocoon-making, and the maternal care for the young. Other observations have also been included on moult, and in some cases on feeding habits.

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[1] Contribution from the Zoological Laboratory of the University of Pennsylvania.

The genera studied and the families in which they are grouped are the following: Lycosidæ (*Lycosa*, *Pardosa*, *Pirata*, *Ocyale*), Agalenidæ (*Tegenaria*, *Agalena*), Dictynidæ (*Dictyna*), Theridiidæ (*Theridium*, *Teutana*, *Steatoda*, *Linyphia*), Pholcidæ (*Pholcus*), Epeiridæ (*Epeira*, *Acrosoma*), Thomisidæ (*Xysticus*), Philodromidæ (*Philodromus*) and Drassidæ (*Prosthesima*, *Thargalia*, *Drassus*). The Attidæ were purposely omitted, since good work has been done upon them by the Peckhams.

The method employed was to keep the smallest species in glass test-tubes, the others in glass boxes of various sizes. A considerable variety of the latter were made by using microscope slides and old photographic plates from which the films had been removed. Strong gummed linen was used for holding the parts together. A very convenient glass cage for observing the mating of small Lycosids is to take a photographic plate 11 x 8 cm. as a base, three microscope slides (each measuring 7.5 x 2.5 cm. or 7.5 x 4 cm.) as the walls, arranged together in a triangle with their narrow diameter vertical to the base, and the ends of two of the slides with just sufficient aperture between them to allow the placing of another slide as a movable partition; and finally two slides, each 7.5 x 4 cm., as covers. Where the edges of any two of the walls meet at an angle a strip of gummed linen is pasted on, also at the angle of each wall with the floor; and by gummed linen strips the glass covers are hinged to the upper edge of one of the walls. Thus one can make a tight and strong cage, with two compartments separated by a glass partition, and each compartment with its own hinged cover. Other cages were made rectangular without movable partitions; and for the larger species, and for those that make webs, large cages were made of photographic plates entirely. Such cages are readily and cheaply made, and more than a hundred of various sizes and forms were employed. Their advantages are obvious. The whole is of glass, the linen strips which hold them together can be made narrow and short and placed so as not to interfere with any observation. The floor being also of glass, one has simply to hold the cage over a mirror to see the spiders from underneath, and its surface retains in drop-form water introduced for drinking purposes. When the floor has become soiled with excrement or remains of food, the gummed linen that holds it to the walls may be torn off, the floor washed, then returned and gummed into position again. It is of great advantage to have the floor removable in the case of species which build a web in the upper part of the cage, for then it may be removed and cleaned without injury to the web. For species that cannot

easily climb the smooth glass walls, such as the heavier Epeirids, threads may be tied upon these walls to give them a foothold. To observe burrowing habits one should put earth in the cages.

Small spiders may be used as food when insects are not obtainable, house flies at other times. All ground spiders need water frequently, and the species of *Pirata* quickly die from thirst. Attempts to feed the spiders with beef extract were unsuccessful.

It is by no means sufficient, however, to simply place the spiders in their glass cages. Great patience in expectant watching is demanded, and no results can be gained unless long continuous periods can be given to this watching. To observe the mating, the spiders should be collected in their natural mating season, and mature males introduced to females which have just become mature; and in the case of the Lycosidæ the collecting should commence in the early spring. Partition cages are most useful for the spiders which do not spin webs, as they obviate any handling; in the web-making species the male should be gently dropped from a test-tube upon the web of the female; in no case should the spiders be handled with forceps. Freshly caught specimens generally give the best results. The considerable number of deaths which resulted during the month of September were mainly on account of starvation, due to my absence at that time.

This contribution is divided into three parts: Observations, General Considerations, and a list of the literature bearing upon the subjects of courtship, mating, parthenogenesis, cocooning, sexual selection, and care of eggs and young. The literature list it has been my aim to make as complete as possible.

The species of *Dictyna, Teutana, Steatoda, Linyphia, Xysticus, Drassus* and *Philodromus*, Mr. Nathan Banks, Assistant in the Division of Entomology, U. S. Department of Agriculture, has kindly identified for me, and it gives me pleasure to express my thanks here for this service.

Finally, I would dedicate the work to the one who cheered long vigils of observation with her sympathy.

Lycosa stonei Montg. Pl. V, fig. 10.

This small species is found abundantly in local woods in the spring and early portion of the summer, running upon the dead leaves on the ground. Later in the summer it becomes rarer, the females then hiding themselves under stones, and the males disappearing. The general coloration of the female is an admirable adaptation to the color of dead leaves; the male is smaller, mainly deep black in color, and the tibiæ of his first pair of legs are covered with vertically implanted bristles,

not so conspicuously, however, as the male of *L. ocreata pulchra*. It is very readily kept in captivity, when supplied with sufficient water.

Individuals observed, males: No. 34, captured May 4, immature, killed May 10; No. 37, captured May 4, moult May 24, killed the same day by a ♀; No. 151, captured May 26, killed by ♀, June 16; No. 164, captured May 31, killed by ♀ on the same day; No. 236, captured June 22, killed by parasite July 21; No. 238, captured June 22, died July 8; No. 240, captured June 22, died June 27; No. 284, captured July 2, died July 7.

Individuals observed, females: No. 36, captured May 4, moult May 7, died in November; No. 51, captured May 6, killed May 11 (then immature); No. 165, captured May 31, still living; No. 184, captured June 10, died October 4; No. 227, captured June 27, still living; No. 228, captured June 22, escaped July 20; No. 229, captured June 22, escaped August 11; No. 230, captured June 22, escaped late in September; No. 231, captured June 22, died October 18; No. 237, captured June 22, killed by parasite July 3; No. 239, captured June 22, killed by parasite August 26; No. 241, captured June 22, moult July 19, killed by parasite about September 8; No. 244, captured June 22, moult July 3, died August 16 (then not mature); No. 285, captured July 2, killed by parasite about September 1; No. 287, captured July 2, killed by parasite about September 30; No. 324, captured July 23, still living.

Moult.—♀ No. 244 moulted in about half an hour, hanging to the wall of her cage by her spinnerets; she fell out of the old skin, which was split horizontally along its whole length backward almost to the spinnerets. ♂ No. 37 took only a few minutes to complete his moult.

Mating.—The following records were made on this process:

(1) ♀ No. 36. Several males were put in her cage before she had completed her final moult, on May 7, but there was no courtship. Then after similar results with males Nos. 34 and 37, the latter was introduced again on May 24, when she killed him. On May 27 ♂ No. 151 was introduced; courtship followed but no copulation. At 2.15 P.M. on May 28, the same male was put in and immediately started his courting motions. These consisted of the following movements: The male generally walks with his first pair of legs stretched before him, tapping the ground with them occasionally; this is evidently to feel the objects in front of him. When he had touched the female with them, he immediately recognized her sex, stood higher upon his legs, raised his first pair and flexed them backward at the femoro-tibial joint, then straightened them out in front of him again, repeating this several times, and at the same jerking his whole body backward and forward with the movement without changing the position on the ground of the other feet; there was no waving of the palpi. He left her, walked around the cage, returned and repeated the motions; they were then face to face, when she lowered her head to the ground,

flexed her legs closer to her sides and, so to speak, cowered before him. Then from in front he walked over her head, and embraced her tightly with his three anterior pairs of legs; his head was pointed toward her posterior end and just above the pedicel of her abdomen. In the copulation he would turn his cephalothorax first a little to one side of her body, then to the other, throwing both palpi over that side of hers to which he had turned. When his head was turned toward her right side, his right palpus would be stretched down along the right side of her abdomen and inserted in the epigynum; when toward her left side, the left palpus would be inserted. Thus to alternate the palpi he had each time to slightly change his position upon her, but the grip of his legs remained unchanged. Each palpus would be rubbed against her epigynum until inserted, then kept there until an invaginated swollen sac of the palpal organ had collapsed, a period not exceeding twenty seconds, when the palpus would be withdrawn and rubbed between his chelicera. The following palpal insertions were made, the abbreviations *r* and *l* being used for right and left palpus respectively, the first numbers giving the time extent, the second the number of insertions into the epigynum: r, 2.18–2.20, 3 or 4; l, 2.20–2.21, 5; r, 2.21–2.28½, 4; l, 2.28½–2.31½, 7; r, 2.31½–2.38¼, 6; l, 2.38¼–2.53½, 15; r, 2.53½–3.01, 9; l, 3.01–3.11, 7; r, 3.11–3.19, 6; l, 3.19–3.26, 5; r, 3.26–3.30, 3; l, 3.30–3.36¼, 4; r, 3.36¼–3.38, 4; l, 3.38–3.42½, 3; r, 3.42½–3.46, 3; l, 3.46–3.50½, 3; r, 3.50½–3.59, 4; l, 3.59–4.04, 3; r, 4.04–4.07, 2; l, 4.07–4.12, 2; r, 4.12–4.18½, 3; l, 4.18½–4.23½, 2; r, 4.23½–4.26, 1; l, 4.26–4.28, 1; r, 4.28–4.31, not inserted once. Then he rose and moved away and was taken from the cage; she remained motionless for several minutes afterward in the same attitude; her only movements during the copulation was to flex the side of her abdomen upward to meet the palpus applied. This copulation lasted 2 hours and 13 minutes. At 7.40 P.M. on the same day he was put in again, but she received him hostilely with upraised fore-legs. On May 29, when introduced, he courted again, but she was hostile, and this was repeated on May 31.

(2) ♀ No. 51 was immature, and was very aggressive to ♂ No. 41, whom she killed on the last occasion; he had made no courting movements. As other females of this species, when she is hostile to a male, with uplifted fore-legs she moves very slowly and stealthily toward, then makes a quick rush at the male.

(3) ♀ No. 165 killed on May 31 ♂ No. 164, after courtship. ♂ No. 151 was introduced on June 2, but though he courted at first, he soon ceased by reason of her aggressiveness. On June 3 the same male

was put in for more than an hour; he courted with interruptions, she would sometimes jump at, sometimes run from him. On June 5 the same male was introduced at 5.00 P.M. He immediately commenced his courting motions and came close to her, when she jumped at him; he turned away and walked around the cage, still courting, came back face to face with her; she lowered her outstretched fore-legs, bent her head to the ground, and he embraced her and commenced the copulation. The attitudes were as in the case of ♂ No. 151, ♀ No. 36. The copulation lasted from 5.02 until 6.17 P.M., that is 1 hour and 15 minutes; the palpi were quite regularly alternated, the right used 12 times and the left 13 times. The male then rose and left her, and was removed; the female remained in the same position until 6.24. In the early part of the copulation the palpus was kept inserted for 4–5 seconds; in the latter part, for 20 seconds.

(4) ♀ No. 184 made her cocoon on June 29, and so was pregnant when I introduced ♂ No. 151 on June 12 and 13; both times she reacted hostilely to his courtship.

(5) ♀ No. 237 was parasitized. On June 22, 23 and 26, ♂ No. 236 was introduced and courted each time, but she was hostile. In his courtship both legs of the first pair were not always moved in unison, but sometimes alternately.

(6) ♀ No. 239 was also parasitized. On June 22, 23 and 24, ♂ No. 238 was placed in her cage and he courted, but she repulsed him each time. June 26 ♂ No. 236 (just after his courtship of ♀ No. 237) courted her, but in vain, and this was the case with ♂ No. 238 on July 1.

(7) ♀ No. 241, likewise parasitized. ♂ No. 240 was introduced on several occasions, but though he courted there was no response.

(8) ♀ No. 244 was not mature, and males Nos. 267, 284 and 326 when introduced did not court.

Thus there is quite a distinct courtship by the male of the mature female, even when she is pregnant. The courting motions are modifications of the cautious feeling motions; the stretching out of the first pair of legs enables the male to feel and so to guard himself. Even in his ardor, then, the instinct of caution toward a stronger individual is not lost. When the female stands high upon her legs and stretches out her fore-legs, it is the same attitude of guard but with offensive intent; a frightened female, when attacked by a stronger individual, does not make use of this attitude, but slinks away. The female shows her willingness to the male by depressing these fore-legs. The bristly tibiæ of the male are shown off by the courting movements of the male;

but other Lycosids without such armature make similar movements. That sight pays a considerable part in the mating of this, as of other Lycosids, is shown by the actions at a distance. But apparently the first recognition of sex is by touch.

Sperm-induction.—♂ No. 151 concluded his copulation with ♀ No. 165 at 6.17 P.M., June 5. At 7 P.M. of the same day he cleaned himself, then went to one corner of the cage and commenced to brush his spinnerets over the floor. He formed a roughly-made small sheet of web of triangular outline, one side of it on the floor, one on the wall of the cage, and the third (the longest) free in the air from the wall to the floor. With his chelicera he then tore away some of the silk on this free edge, making it smoother there, doing so from 7.10 to 7.25. Next he placed himself above the sheet as follows: The ventral surface of his cephalothorax upon the upper free edge of the sheeting so that his palpi hung down over this edge, his abdomen slightly elevated above and parallel to the sheet, the legs of his right side against the vertical glass wall, those of his left upon the floor. At 7.28 a small yellowish drop of sperm, its diameter not greater than that of one of his metatarsi, fell from his genital aperture on the superor surface of the sheet at about its middle point. He then reached his palpi downward and backward, below the sheet, and applied the concave portion of the palpal organ of each against that part of the sheet which carried the drop of sperm. Each palpus was thus rubbed against the lower surface of this drop several times, then withdrawn and slowly shaken in the air, while the other was similarly applied to the drop. This continued until 7.35, by which time all of the sperm had been taken into the palpal organs. He remained perfectly quiet in the same position up to 7.53, depositing no more sperm, and then walked about the cage.

Cocooning.—The cocoon is a nearly globular bag, and the mode of making it was seen several times, of which these will serve as examples:

(1) ♀ No. 231 was observed on June 28, at 7.30 P.M., spinning a circular disk of silk ("base" of the cocoon) on the floor, close to the edge of a nearly evaporated drop of water. This base's diameter did not quite equal the length of her body. She was then brushing her spinnerets from side to side, and rotating her body at intervals. At first she made frequent pauses, but fewer as she proceeded, and gradually enlarged the diameter of the base until it quite equaled the length of her body. This continued until 8.15, when she changed the method of spinning, and started to build a silken wall upon the margin of the base; this she accomplished by elevating her spinnerets high in the air after each stroke, then applying them again close to the first point of

attachment of the threads, thus laying down looped threads. As she did so she rotated her body slowly, keeping the tips of her palpi pressed against the portion of the margin opposite the one to which she applied her spinnerets. So she formed a narrow marginal wall, low but quite visible to the naked eye, made entirely of looped threads. This was finished at 8.35. Then she stood so across the cocoon base that her palpi touched the wall in front and her spinnerets the wall behind, and oviposited upon the centre of the base. From her genital aperture fell a large drop of viscid fluid, its upper surface remaining adherent to her genitalia, and the yellowish ova dropped into it one by one. The oviposition lasted from 8.36 to 8.41, when she tore herself loose from the viscid drop and started to spin the cover of the cocoon. She spun over the egg mass uninterruptedly from 8.41 to 8.59, forming a dense covering and battening the silken wall down at the same time. From 8.59 to 9.01 she occupied herself with loosening the cocoon from the glass floor of the cage, doing so by seizing with her chelicera and pulling first one part of the edge of the base, then another, bracing her legs firmly against the ground, until she had completely loosened it. She then held it a moment attached to her spinnerets, then from 9.02 to 9.24 held it below her cephalothorax with her third pair of legs, revolving it in this position with her palpi, and spun upon its surface with abdomen flexed vertically downward. Thus was formed a perfect globular cocoon, white in color.

(2) ♀ No. 228 was observed at the close of the cocooning, which was like that of the preceding case.

(3) ♀ No. 229 did not spin the base of her cocoon directly upon the floor of the cage, but upon a scaffolding of threads inclined at a slight angle to the floor and joined to the wall. From 11.03 to 11.17 A.M. she was occupied in spinning the marginal wall, from 11.18 to 11.22½ in the oviposition, from 11.23 to 11.58 in making the covering (in the first part of which she elevated her spinnerets and did not brush them, thus preventing them from adhering to the viscid drop), from 11.58 to 12.02½ in tearing the cocoon loose, and from 12.05 to 12.30 in spinning upon the cocoon while held beneath her body.

These three were the only normal cocoon-makings observed. This species is peculiar in sometimes making the base of the cocoon without a preliminary scaffolding.

All the other cases resulted disastrously, due either to the spinnerets of the mother becoming clogged with the viscid substance surrounding the eggs, or, in most of the cases, to her making the mistake, when tearing the cocoon loose from the floor, of tearing the cover from

the base, thereby leaving the egg mass exposed. In all these cases the first part of the cocooning and the oviposition proceeded normally; the mistake was in making the cover or in tearing the cocoon loose. And once a mistake in the progress was started none of these individuals were able to rectify it, though one tried for a few moments to spin over the rent in the cocoon, and each in conclusion chewed up either the imperfect cocoon or the eggs; when the cover was torn off the eggs, the spider would very frequently chance to break some of the latter, and once she tasted their contents she would eat them. They would seem perplexed after a cover had separated from the base, would remain still a long while, would feel with the palpi first the cover and then the egg mass on the base; usually they would take the isolated cover beneath the body and spin upon it there, as they do with a normal cocoon, but did so irregularly. An isolated cocoon cover was never carried attached to the spinnerets more than a short time. One spider had made her cocoon perfect except for a break at one point between the cover and the base; this resulted in an elongated, irregularly conical cocoon, which she dropped from her spinnerets after a few days.

Now the reason for such abnormal cocoons seems to be in a mistake made in tearing the cocoon loose; but there is still a reason back of this one, at least for some of the cases. It was my custom with these spiders, as with the other Lycosids, to put a drop of water upon the floor of their cages every day or two, for them to drink. Three of the miscarried cocoons whose making was observed, were commenced by spinning over the surface of this drop of water. The water in some way mingled with the silk of the cocoon, and at least contributed to making it a failure. Why they should spin over the water I cannot say, except that perhaps the feeling to the touch of the surface of the water may simulate the feeling of a silken layer, and so awaken reflexes to spin at that place. In any case, all the Lycosids and one Philodromid, which chanced to lay the base of their cocoons upon a water surface, made a failure of these cocoons. But in no other species have I experienced such a high percentage of failures as in *Lycosa stonei*.

The number of cocoons, and the dates, were as follows: ♀ No. 36, June 6, a failure; ♀ No. 165, June 25, a failure; ♀ No. 184, June 29, a failure; ♀ No. 227, June 27, July 16, both failures; ♀ No. 228, June 25, July 14, the second one a failure; ♀ No. 229, June 29, a perfect cocoon, but cut open too soon by the mother, so that the eggs rolled out; ♀ No. 230, June 27, July 14, both failures; ♀ No. 231, June 22, a perfect cocoon, but the mother destroyed it.

Care of the Young.—The mother carries the cocoon attached to her spinnerets, bites it open around the equator to allow the young to escape, then carries the latter upon her body for a few days.

Parasites.—One male and six females died from the effects of an endoparasitic dipterous larva. One spider contained two of these parasites, the others one each. After the parasite, whose bulk nearly equals that of the body of the spider, has eaten away most of the soft parts of the spider, it emerges through a hole it makes in the wall of the abdomen of the spider, and this emergence kills the host. It is strange that these spiders should live so long with such a huge parasite within them. A short time before the parasite escapes the spider acts in a peculiar manner, walking about spasmodically and often spinning aimlessly. The most remarkable case of this kind was the following: ♀ No. 237 occupied July 3 in spinning a completely closed, oblong sack, with a ength of 30 mm. and a greatest depth of 20 mm. This silken sack was placed in the angle between two vertical walls and the roof of the cage, and its contours were rounded where not in contact with the glass. This completed around her, she remained in it until the evening, when the large parasite emerged. An indirect explanation may be that lhe parasite irritated the nervous centres governing her spinning apparatus, she was thus instigated to spin, and it was merely a coincidence that she chanced to surround herself with a sack.

Two of the parasitic larvæ which emerged I kept until they perfected and developed into winged imagos. My friend, Mr. Charles W. Johnson, identified them as Acrocerids.

Lycosa cocreata pulchra Montg.

Individuals observed, males: No. 91, captured May 18, killed by ♀ No. 186, June 12; No. 110, captured May 19, killed May 31; No. 170, captured May 31, killed by ♀ No. 171, June 7.

Individuals observed, females: No. 92, captured May 18, moult July 12, killed July 12; No. 111, captured May 19, killed May 31; No. 171, captured May 31, escaped June 13; No. 186, captured June 10, still living; No. 317, captured July 14 (then with a cocoon), died October 4.

Moult.—On July 12 ♀ No. 92 was found on the floor of her cage, evidently dead; she was put in alcohol, but then moved vigorously, and the old skin on the dorsal side of her thorax separated off. Accordingly she was in the quiescent state of a beginning moult. The remarkable point of this moult was that on June 3 she had copulated—*i.e.* a copulation had preceded the last moult.

Mating.—The following cases were seen:

(1) ♀ No. 92. ♂ No. 91 was placed with her for three hours on

the night of May 18, but there was no attempt at mating; this was repeated during two hours on the following night, as also on May 28 and May 31. At 8.10 P.M., June 3, the same male was again introduced. She moved about at intervals, he avoiding her, up to 9.12. Then I chanced to look at another cage for half a minute, and when I looked back found the pair in copula. The position was the one usual for this genus, he above her with his head pointed toward the posterior end of her abdomen and his three anterior pairs of legs holding her tightly; his first patellæ were just behind her fourth femora, his second patellæ behind her third femora, his third patellæ behind her second femora. Only one palpus was inserted at a time; when his right palpus was used his head was turned obliquely over the right side of her body; when his left was used, over the left side. The sequence of usage of the palpi, the time, extent, and the number of times each was inserted before the other was used, was as follows (using the abbreviations *r* and *l* for right and left palpus respectively): r, 9.13–9.13½, the number of times not noted; l, 9.13½–9.14½, 3; r, 9.14½–9.15½, 3; l, 9.15½–9.17, 4; r, 9.17–9.19, 5; l, 9.19–9.21, 4; r, 9.21–9.23½, 5; l, 9.23½–9.26¾, 6; r, 9.26¾–9.29, 5; l, 9.29–9.33, 6; r, 9.33–9.37, 4; l, 9.37–9.41, 5; r, 9.41–9.43, 2; l, 9.43–9.47, 3; r, 9.47–9.50, 3; l, 9.50–9.53, 2; r, 9.53–10.02, 4; l, 10.02–10.04½, 2. He made each palpal insertion by reaching the palpus down and rubbing it against her epigynum, and while it was inserted a large sac evaginated from the side of the palpal organ; the palpus was kept inserted until this sac collapsed, a period of about 15 seconds in the earlier part of the copulation, and of 30–40 seconds in the latter part; then the palpus was withdrawn and rubbed against his mandibles. At the end of the copulation (which had lasted 52 minutes) the male rose and walked off, immediately proceeding to the act of sperm-induction.

(2) ♀ No. 111 was immature, and when ♂ No. 110 was placed with her they avoided each other.

(3) ♀ No. 171. ♂ No. 170 was placed in her cage May 31, and again on June 1 and 3, but no mating followed. On June 7 the same male was introduced at 8.49 P.M. From then until 8.51 they were motionless with their legs touching, when each backed off a little, he then in his characteristic attitude of defense, with his first pair of legs drawn up and back so that their patellæ touched the top of his cephalothorax. At 8.52 he quivered these legs, she made a step toward him, then both remained still with uplifted fore-legs. At 8.54 she made another short step toward him, not aggressively, *i.e.*, without uplifted fore-legs, but he backed off a little as before. At 8.55 he

made a short jump upon her, and quickly got into copulatory attitude, she motionless in his embrace. Their position was as in the case of ♀ No. 92.×♂ No. 91; the act lasted from 8.55 to 10.22 P.M., 1 hour and 27 minutes; the palpi were inserted alternately, the right 16 times and the left 15 times. Then he rose, she also started up quickly, chased and killed him within a few seconds, and ate him.

(4) ♀ No. 186 was pregnant when I introduced ♂ No. 91 on June 12, and she killed him.

In all these cases there was no sign of a courtship on the part of the male; after touching the female, he would raise his fore-legs in defensive attitude, and if she was desirous she would approach him with lowered fore-legs, otherwise she would try to kill him. Now there is a noticeable secondary sexual difference: the tibiæ of the first pair of legs of the male only are covered thickly with long, vertically implanted black bristles, making them look like miniature test-tube brushes. When the male stands before the female with these legs flexed, as he does, with the patellæ close to the sides of his cephalothorax and his body crouched near the ground, the tibiæ are more horizontal than inclined upward. This, then, is not the best attitude to exhibit them to the female; they would be best shown off if they were directed vertically upward. On this account, this bristling of the tibiæ can hardly be regarded as a sexual ornament that is exhibited to charm the female. Further, it may be noted that this position of the first pair of legs is also assumed by the female when roughly handled or frightened; it is an attitude of defense of the species, not of sexual exhibition. These bristles are possessed only by the mature males. I could not determine that they serve any particular purpose, though certainly they give these legs a firmer hold upon the abdomen of the female during copulation.

Sperm-induction.—♂ No. 91, immediately after his copulation with ♀ No. 92 on June 3, moved to another corner of her cage and spun upon the floor from 10.11 to 10.15. Then as he was interrupted by her approach, I separated her by use of the sliding partition. He commenced spinning again at 10.19, at the angle of a wall and the floor, brushing his spinnerets to and fro upon the glass, on the floor and on the wall, all the time beating the tips of his palpi upon the overspun area. This continued up to 10.32, when a fine covering of silk, barely visible with a hand lens, covered that part of the floor. At 10.32 he elevated his abdomen slightly, still standing over the silken covering, and discharged a minute globule of sperm from his genital orifice upon the silk sheeting. This globule rolled to the ventral

surface of his sternum, and he then applied the tips of his palpal organs alternately to this part of his sternum, and rubbed them against it; this was evidently the process of taking the sperm into his palpi, though I could not see the drop at this time. This continued from 10.32 to 10.37, then he ceased, and did not repeat the process up to 11.40, when I ended the observation.

Cocooning.—This was seen only once. ♀ No. 186, on June 21, at 11.35 P.M., was found spinning on the floor in a corner of the cage, slowly and with frequent pauses. She soon ceased, but began again at 1.30, and at 1.50 had made, upon a scaffolding of lines passing from the floor to the wall and inclined at an angle of 40°, a white, circular silken disk, the base of the cocoon. The diameter of this base was about equal to the length of her body. She continued to spin upon it up to 2.27, but slowly and with frequent rests. In the earlier portion of this time the spinnerets were brushed from side to side, before backward rather than from side to side, and she rotated her body but little. In the later portion she spun mainly upon the margin of the base, and formed there a barely perceptible wall of curled threads made by elevating her spinnerets after each stroke, and rotated her body while spinning. She stood with the tips of her palpi and her first and second pairs of feet upon the edge of the silken disk (base), her other feet upon the surrounding scaffolding. At 2.27 she stood quiet over the base with her head turned toward its highest edge, discharged a large drop of yellowish fluid of viscid consistency upon the centre of the cocoon base, and, while the upper surface of this drop still adhered to her epigynum, dropped the ova into it one by one. At 2.31½ she started to break loose from this drop, but half a minute passed before she was able to do this, the surface of the drop adhered to her so firmly. At 2.32 she commenced spinning the cover to the egg mass with a brushing movement of the spinnerets, and, except for a pause from 2.35 to 2.37½, this continued up to 2.57. Thus the egg mass (within its viscid drop) was flattened down and was evenly covered with silk. The time from 2.57 to 3.01 was occupied in biting loose the margin of the cocoon from the surrounding scaffolding. The cocoon at this stage was lenticular, and the margin of the base projected beyond the cover. At 3.02 she held it beneath her cephalothorax, holding it there with her third pair of legs and slowly revolving it with her palpi and chelicera; at the same time she spun upon it, holding her abdomen bent vertically downward. She then fastened it to her spinnerets and so carried it about, spun on it for a short time again at 3.26, then hung it definitely to her spinnerets and was not seen to spin upon it any more that day.

The peculiar part of the above cocooning, in comparison with other Lycosids, was its slowness, pauses occupying more time than the spinning itself.

The number of cocoons, and the dates, were as follows for ♀ No. 186: June 21, this one did not hatch, but was chewed up by the mother; July 13, this also did not hatch.

Care of the Young.—The cocoon is normally carried attached to the spinnerets until it hatches. ♀ No. 317, who was captured with a cocoon, bit it nearly in two around the equator to allow the young to escape; the young took above four hours on July 15 in leaving the cut cocoon to get upon her body, and the first of them left her on the night of July 19.

Lycosa scutulata Hentz.

Individuals observed, males: No. 232, captured June 22, moulted July 11, killed by ♀ No. 273, August 21; No. 233, captured June 22, moulted July 2 and 18, killed by ♀ No. 271, August 25; No. 275, captured June 27, moulted July 14, killed by ♀ No. 273, August 25.

Individuals observed, females: No. 271, captured June 27, moulted July 1 and 20, still living; No. 273, captured June 27, moulted July 3, 14, 31, still living; No. 278, captured July 2, moulted July 3, died July 24 (then immature); No. 326, captured July 23, moulted July 24, still living.

Moult.—♀ No. 273 was found at the conclusion of the process at 10.30 P.M. The exuvia was upside down and attached by its feet to web-lines in the upper part of the cage; the spider was hanging attached to it by her spinnerets. She did not start moving until 10.42; at 10.57 she walked away from the old skin, and then remained quiet for half an hour more. The old skin breaks by a horizontal split, as in other spiders.

Mating.—The following cases were seen:

(1) ♀ No. 273. After her penultimate but before her final moult ♂ No. 232 was introduced in her cage on July 15, 16 and 18. Though he was still immature he courted her on all these occasions; and he courted her at frequent intervals when they were not together in one cage, recognizing her at a distance of several inches through the glass of the cages. When courting he held his body close to the ground, his last three pairs of legs stretched out nearly straight, but his first pair of legs were flexed at the femoro-patellar joint so that the femora were drawn back over his cephalothorax, the tibia and tarsus held nearly horizontally in the air. Then first, the palpi are swung outward and upward in alternation, each five or six times; second, one leg of the first pair is pushed forward and its foot tapped 6–10 times upon the floor in front of him, being

pushed forward a little after each tap, the abdomen twitching in time with the tapping of the foot; and, third, the leg is withdrawn and flexed over the cephalothorax again. This process occupies from 10 to 15 seconds, then there is a short pause, followed by a repetition of the act in which the opposite leg is pushed forward. This may be repeated several times without his moving from one spot, and not only when he is not facing the female, but also when he is at some distance from her. When he is facing her, and evidently sees her, while courting he advances toward her, taking a very short step forward during each act of courtship; sometimes he may advance as much as 2 or 3 millimeters at a time, sometimes again by still smaller steps, the rate increasing somewhat as he comes nearer to her. In case the female moves away in a course at right angles to his line of vision, he quickly turns around to keep her in view, but does not hasten his slow advance. I have also seen males when in their own cages, and out of all view of a female, commence to make these courting motions, even to continue them for some hours; but unless the female is in view, they do not advance while courting. This immature female, while being courted, plainly saw him, and would move away from him without his touching her; she made no determined hostile rushes upon him, and he did not appear afraid of her. Sometimes she assumed an attitude of defense, the long axis of the body at an angle to the floor with the spinnerets touching the floor, and the first and second pairs of legs elevated and stretched out before her. On July 31 she completed her final moult, and on August 1 the same male was introduced at 9.20 P.M., and kept in until 10.30; he courted, but she avoided him. He was introduced again on August 21, at 10.33 A.M., saw her at 10.36, and immediately commenced courting; at 10.38 she turned to face him and touched him with her fore-legs, when he immediately climbed over her head, embraced her and commenced the copulation. The attitude of the embrace was the same as in other Lycosids—the male above the female facing in the reverse direction, his head above the pedicel of her abdomen, grasping her with his three anterior pairs of legs; the female with legs outsprawled, and making only the movement of flexing the ventral surface of her abdomen upward on its long axis so as to bring her epigynum within reach of his palpal organ. The male lies rather obliquely across the female so as to extend his palpal organ downward to reach the epigynum; when he lies obliquely across her right side he employs his right palpal organ only, when across her left side his left palpal organ. During the time of each palpal insertion a large sac on the median

side of the palpal tarsus swelled up, and the palpus was not withdrawn until this sac had collapsed; when a palpal organ was withdrawn it was each time drawn through the chelicera before it was inserted again. The following figures give the details of the copulation, *r* and *l* being used for right and left palpus respectively, and the numbers giving the time duration: r, 10.39$\frac{3}{4}$–10.41; l, 10.41–10.41$\frac{1}{4}$; l, 10.41$\frac{1}{2}$–10.42; r, 10.42–10.42$\frac{1}{2}$; l, 10.43–10.43$\frac{1}{5}$; l, 10.43$\frac{1}{2}$–10.44; r, 10.44$\frac{1}{2}$–10.44$\frac{3}{4}$; l, 10.45–10.45$\frac{1}{2}$; r, 10.45$\frac{1}{2}$–10.46; l, 10.46$\frac{1}{2}$–10.47; r, 10.47$\frac{1}{5}$–10.47$\frac{1}{4}$; r, 10.47$\frac{1}{2}$–10.48$\frac{1}{3}$; r, 10.48$\frac{1}{2}$–10.49; l, 10.49$\frac{1}{2}$–10.49$\frac{7}{8}$; r, 10.50–10.50$\frac{1}{8}$; l, 10.50$\frac{1}{2}$–10.51; r, 10.51$\frac{2}{5}$–10.51$\frac{3}{4}$; l, 10.52–10.52$\frac{1}{5}$; r, 10.52$\frac{1}{4}$–10.53; r, 10.53$\frac{1}{2}$–10.54; l, 10.54$\frac{1}{3}$–10.54$\frac{4}{5}$; l, 10.55$\frac{1}{4}$–10.55$\frac{1}{2}$; l, 10.55$\frac{3}{4}$–10.56; r, 10.56$\frac{1}{5}$–10.56$\frac{3}{5}$; l, 10.57–10.57$\frac{1}{5}$; r, 10.57$\frac{1}{2}$–10.57$\frac{3}{5}$; l, 10.57$\frac{3}{4}$–10.58$\frac{2}{5}$; r, 10.58–10.58$\frac{7}{8}$; l, 10.59–10.59$\frac{1}{4}$; r, 10.59$\frac{1}{2}$ (2 seconds); r, 10.59$\frac{3}{4}$–11.00; l, 11.00$\frac{1}{4}$–11.00$\frac{3}{4}$; r, 11.00$\frac{7}{8}$–11.01$\frac{1}{4}$; l, 11.01$\frac{1}{2}$–11.01$\frac{3}{4}$; r, 11.02–11.02$\frac{1}{3}$; l, 11.02$\frac{1}{2}$–11.03; r, 11.03$\frac{1}{7}$–11.03$\frac{2}{5}$; l, 11.03$\frac{3}{4}$–11.04; r, 11.04$\frac{1}{10}$–11.04$\frac{2}{5}$; l, 11.04$\frac{7}{8}$–11.05; r, 11.05$\frac{1}{10}$–11.05$\frac{1}{2}$; l, 11.05$\frac{3}{5}$–11.06; r, 11.06$\frac{1}{8}$–11.06$\frac{2}{5}$; l, 11.06$\frac{3}{5}$–11.07; r, 11.07$\frac{1}{10}$–11.07$\frac{1}{3}$; l, 11.07$\frac{3}{5}$–11.07$\frac{9}{10}$; r, 11.08–11.08$\frac{1}{3}$; l, 11.08$\frac{1}{2}$–11.08$\frac{7}{8}$; r, 11.09–11.09$\frac{1}{4}$; l, 11.09$\frac{1}{2}$–11.09$\frac{9}{10}$; r, 11.10–11.10$\frac{1}{3}$; l, 11.10$\frac{3}{4}$–11.11; r, 11.11$\frac{1}{7}$ 11.11$\frac{3}{8}$; l, 11.11$\frac{1}{2}$–11.12; r, 11.12$\frac{1}{10}$–11.12$\frac{1}{3}$; l, 11.12$\frac{1}{2}$–11.12$\frac{9}{10}$; r, 11.13–11.13$\frac{1}{4}$; l, 11.13$\frac{1}{2}$–11.13$\frac{9}{10}$; r, 11.14–11.14$\frac{1}{2}$; r, 11.14$\frac{1}{8}$–11.14$\frac{3}{5}$; l, 11.14$\frac{9}{10}$–11.15$\frac{1}{5}$; r, 11.15$\frac{1}{3}$–11.15$\frac{3}{4}$; l, 11.16–11.16$\frac{1}{5}$; r, 11.16$\frac{1}{4}$–11.16$\frac{2}{5}$; r, 11.16$\frac{3}{5}$–11.16$\frac{3}{4}$; l, 11.16$\frac{7}{8}$–11.17$\frac{1}{10}$; r, 11.17$\frac{1}{2}$–11.17$\frac{3}{4}$; l, 11.17$\frac{7}{8}$–11.18$\frac{1}{5}$; r, 11.18$\frac{1}{4}$–11.18$\frac{1}{2}$; r, 11.18$\frac{1}{2}$–11.18$\frac{7}{8}$; l, 11.19–11.19$\frac{1}{4}$; r, 11.19$\frac{1}{2}$–11.19$\frac{7}{8}$; r, 11.20$\frac{1}{10}$–11.20$\frac{1}{5}$; l, 11.20$\frac{1}{4}$–11.20$\frac{3}{5}$; r, 11.20$\frac{7}{8}$–11.21 ; l, 11.21$\frac{1}{3}$–11.21$\frac{3}{4}$; r, 11.21$\frac{7}{8}$–11.22$\frac{1}{12}$; l, 11.22$\frac{1}{4}$–11.22$\frac{3}{4}$; r, 11.23–11.23$\frac{1}{12}$; l, 11.23$\frac{1}{3}$–11.23$\frac{3}{4}$; r, 11.23$\frac{7}{8}$–11.24$\frac{1}{10}$; l, 11.24$\frac{3}{8}$–11.24$\frac{7}{8}$; r, 11.25$\frac{1}{2}$–11.25$\frac{7}{8}$; l, 11.25$\frac{9}{10}$–11.26$\frac{1}{5}$; r, 11.26$\frac{3}{5}$–11.26$\frac{3}{4}$; l, 11.26$\frac{7}{8}$–11.27$\frac{1}{8}$; r, 11.27$\frac{1}{5}$ (10 seconds); r, 11.27$\frac{7}{8}$–11.28; l, 11.28$\frac{1}{6}$–11.28$\frac{3}{5}$; r, 11.29–11.29$\frac{1}{4}$; l, 11.29$\frac{1}{2}$–11.29$\frac{7}{8}$; r, 11.30–11.30$\frac{1}{2}$; r, 11.30$\frac{1}{5}$–11.30$\frac{1}{4}$; l, 11.30$\frac{2}{5}$–11.30$\frac{7}{8}$; r, 11.31$\frac{2}{5}$–11.31$\frac{3}{5}$; he then revolved upon her; l, 11.32$\frac{1}{2}$–11.32$\frac{7}{8}$; r, 11.33$\frac{3}{4}$–11.34$\frac{1}{5}$; r, 11.35$\frac{3}{5}$–11.36; l, 11.37–11.37$\frac{2}{5}$; r, 11.38$\frac{1}{5}$–11.38$\frac{3}{8}$. Then he moved off her, when she jumped at killed and ate him. On August 25 ♂ No. 275 was introduced, but she caught and ate him too.

(2) ♀ No. 271 completed her final moult on July 20, and on August 22 ♂ No. 233 was dropped upon the floor at 7.28 P.M., while she was upon the wall. He saw her at a distance of 75 mm., but she was placed so that she could not see him, so at 7.35 I pushed her to the floor. He courted and slowly approached her; she made an aggressive movement; he dodged her but continued courting. She approached and touched him, whereupon he immediately got into copulatory

position and commenced the coition. The postures and the mode of copulation were as in the preceding case; the right palpus was employed 84 times and the left 81 times. This copulation began at 7.38 and ended at 8.32½, when she struggled beneath him and he cautiously moved away from her, when I put him into another cage. On August 25 the same male was put with her again, at 2.42 P.M. He courted her steadily, though she made several jumps at him, and he even followed her up the wall still courting. At 4.05 I was obliged to leave, and returning at 4.28 found them in copulation, which continued up to 5.03, when she struggled and he left her. She did not attempt to kill him at first, and he followed her still courting; but about two hours afterward she killed and ate him.

(3) ♀ No. 278 was not fully mature. ♂ No. 275 was placed with her for half an hour on July 16; they grappled, and after that remained quiet. On July he was introduced again and began courting at 5.02, as soon as he saw her, but she ran from him.

(4) ♀ No. 326 finished her final moult on July 24. ♂ No. 275 was placed with her on July 25 and 26, but courted for only a short while each time. There was no courtship at all on July 30 and August 22.

There is, accordingly, in this species a decided courtship; the male differs from the female in his smaller size and in the black color of a portion of his fore-legs, and these legs (and the palpi also) are moved in a particular manner during the courtship. Observation shows that the male recognizes the female as such at a distance of at least six inches. The male's approach to the female is very slow, a kind of creeping, not at all similar to the vehement approach of certain other Lycosids. The male will court immature females. The female, if eager, gives the signal of willingness to the male by touching him lightly with her first pair of legs, when he immediately embraces. In the observed cases, with one exception, the female killed the male at the end of the copulation. The peculiarity of the copulation is that the right and left palpi are inserted in the epigynum in almost strict alternation, that these insertions are very brief and numerous, and that the intervals between them are markedly short. One female copulated twice with the same male at an interval of three days. The time duration of the longest copulation watched was 59 minutes, of the next longest 55 minutes.

Cocooning.—♀ No. 271 made a cocoon in the second week of September, carried it attached to her spinnerets (the normal way) and is still carrying it. ♀ No. 273 made her cocoon during the first week of September, but dropped it from her spinnerets about the 25th of that

month, and did not take it up again, although she frequently touched it; she had not bitten it open before dropping it. The cocoons are nearly globular, white or bluish; their architecture shows them to be composed of two portions, a base and a cover, as in other spiders.

Webs.—All the males spin irregular sheet-like webs inclined at an angle of about 45° to the floor and the wall of the cage. One female also slowly built up an irregular horizontal web. The other species of *Lycosa* observed did not make such webs, but simply short lines to attach themselves to the vertical glass walls of the cages.

Lycosa nidicola Emerton.

Care of the Young.—Six females of this large species were kept; three of them were captured carrying cocoons, while one, after her final moult (which was like that of other Lycosids), formed the base of a cocoon upon a drop of water and oviposited upon it, but this cocoon was a failure.

The large globular cocoon is carried dependent from the spinnerets until it hatches. The mother helps herself in supporting its weight, sometimes by resting it partially against the tarsi of her fourth pair of legs, sometimes standing with her abdomen and the third and fourth pairs of legs upon the wall of the cage, whereby the cocoon rests against the wall. She cuts open the cocoon to allow the escape of the young, then carries the young upon her for a considerable length of time, one female for 11 days, another for 13 days, another for 14 days —longer periods than were observed in other Lycosids. The number of young is also large; in the two cases where they were counted they were respectively 210 and 302 in number. The following notes may be of some interest:

♀ No. 212 was seen on June 23, at 2.00 P.M., holding her cocoon beneath her cephalothorax with her first and third pairs of legs and her palpi, and tearing its lining with her chelicera; she had then scraped away some of the superficial layer along an equatorial line, and at one or two points in this line her chelicera had penetrated to the interior. At 2.22 the first of the spiderlings crawled out through one of these holes, and as soon as the mother felt its motion she quickly fastened the cocoon to her spinnerets and waited patiently. But no more spiderlings emerging, she bit the cocoon again from 2.43 to 2.52, when she suspended it again to her spinnerets. At 3.34 the second and third spiderlings crawled out upon her body, and at 3.39 the fourth. The mother apparently divined that the young were not emerging rapidly enough, and bit the cocoon again from 3.48 to 3.55. At 3.59 the fifth spiderling climbed upon her, at 4.03 about eight more

spiderlings, and at 7.00 there were about twenty upon her. Next day at 9.00 A.M. more young were still emerging, and at 3.00 P.M. she dropped the cocoon (empty of young) from her spinnerets. The young massed together upon her abdomen and cephalothorax made her appear twice her natural size; she did not allow them to get upon her eyes, however, but brushed them away gently with her palpi. On July 2 the first of the spiderlings left her, running down her legs to the ground, and on July 4, when I killed her, only five were left upon her; these I endeavored to rear by keeping them in separate tubes, but all of them died within a few days.

♀ No. 211 was found on June 16, at 2.45 P.M., resting her cocoon (attached to her spinnerets) upon the floor; some of the young on emerging from the cocoon got upon the floor, but these quickly climbed up the legs of the mother. She dropped the cocoon next day, and examination showed that she had gnawed it along its whole circumference, but at only certain points along the line of the abrasion had holes been made to the interior cavity. In this case, as in the preceding, the young that had left the mother's constructed a network of silken lines through the cage; possibly aeronautic lines, such as young Lycosids normally employ to carry them, with the help of the wind, away from the home of the mother.

Lycosa punctulata Hentz.

One female of this, locally rather rare, species was kept and observed from June 10 until her death on August 3.

Cocooning.—On July 1 and 2 she was found spinning upon the floor of the cage. On July 3, at 11.00 A.M., I found she had quite a thick sheeting over the floor and for a little distance up the sides of the cage, covering an area of about 25 x 65 mm. At 1.33 P.M. on that day I found she had constructed an oval disk of white silk (cocoon base) with a diameter about equal to her body length; this base was placed upon the preliminary scaffolding in the corner, and inclined to the floor at a slight angle. From 1.33 to 1.46 she spun a silken wall upon the margin of this base, though when finished it was barely visible to the naked eye. She composed it of looped threads, made by uplifting her spinnerets high at each stroke. She then stood over the centre of the base, and from 1.47 to 1.50 there fell upon the center of the base from her genital aperture a clear drop of viscid fluid, into which fell in succession a number of pale yellowish ova; a second smaller drop from 1.51 to 1.52; and from 1.52 to 1.53 five small drops in succession, each enclosing one ovum. All the drops merged together upon the cocoon base, but the whole mass was small in proportion to

her volume, and evidently she had not deposited all the ova within her since her abdomen was still quite distended. At 1.53½ she commenced spinning the covering, with high strokes of the spinnerets laying down threads that were looped, since a second attachment of the spinnerets would be close to a first; but she placed very few of these over the egg mass, spinning mostly upon the margin of the cocoon base and even upon the foundation beyond it. She spun very slowly, occupied most of the time in pauses, and occasionally walked about the cage. At 2.23, when the egg was only imperfectly covered with a thin silk layer, she loosened with her chelicera about a quarter of the edge of the base from its moorings. She rested, and at 2.27 seized the covering of the egg mass, pulled it, then rested, holding it in her jaws. From 2.35 to 2.37 she spun again upon the margin of the base, then turned about, seized the egg mass with her jaws, began to eat the eggs, and devoured them all by 3.10. Finally, with her chelicera she tore the base completely loose, and ate up that too.

Though this cocooning was a miscarriage, due to faulty oviposition and to insufficient covering to the eggs, yet the method followed would indicate that this species normally cocoons like others of the genus.

Lycosa lepida (Keys.).

Individuals observed, males: No. 150, captured May 26, died early in September; No. 200, captured June 10, died August 15; No. 201, captured June 10, died July 26.

Individuals observed, females: No. 183, captured June 10, died October 12; No. 193, captured June 18, moulted June 18, died October 18; No. 194, captured June 10, died July 5; No. 196, captured June 10, still living; No. 197, captured June 10, still living; No. 203, captured June 10, with a cocoon, killed August 3; No. 214, captured June 10, with a cocoon, died in November; No. 268, captured June 27, died October 2.

Moult.—The old skin splits along the horizontal line as in other spiders.

Mating.—♂ No. 150 was introduced to ♀♀ Nos. 194, 268, 203, 193, 197; ♂ No. 200 to ♀♀ Nos. 194, 197, 203, 268; ♂ No. 201 to ♀♀ Nos. 196, 194. No copulation occurred in any case before or after cocooning, and all the females except two were pregnant when captured.

The following observations point to a simple courtship on the part of the male, who is more brightly colored and considerably smaller than the female:

(1) ♀ No. 194. When ♂ No. 201 was placed with her for the second time, he got behind her and shook his fore-legs slowly in the air, these

legs held outstretched before him and elevated only slightly from the ground. This is an action of neither aggression nor fear; aggression is evidenced by standing high upon the legs and stretching out the first pair of legs without shaking them; fear, by holding the body low, and flexing the first pair of legs at the tibial joint back over the cephalothorax.

(2) ♀ No. 196. ♂ No. 201 was put in her cage at 4.47 P.M., June 12. At 6.00 P.M. they faced each other at a distance of about 50 mm.; his body was flat upon the ground, and at intervals he raised his fore-legs, which were stretched out on the floor before him, and shook them tremulously in the air. After several repetitions of this movement he approached her slowly and touched her, making a short step forward with each shaking of his legs, but she rebuffed him.

Cocooning.—The following cases of normal cocooning were seen:

(1) ♀ No. 183 had been caught in a test-tube, and before she was removed to a cage she had made her cocoon there. At 1.10 P.M., when first noticed, she had already laid her eggs upon a silken cocoon base, the diameter of which about equalled the length of her body, and was then spinning the cover by brushing the spinnerets from side to side, at the same time rotating her body over it. From 1.21 to 1.23 she occupied herself with biting the margin of the lenticular cocoon loose from its scaffolding At 1.25 she held the cocoon beneath her cephalothorax, when she was placed in a larger bowl for better observation. There she walked about with it attached to her spinnerets until 1.28, then held it beneath her cephalothorax again with the use of her third pair of legs, and while rotating it with her chelicera and palpi she spun upon it with the abdomen bent downward. This continued until 1.55, when she attached the now round cocoon to her spinnerets.

(2) ♀ No. 196, on June 14, at 5.45 P.M., commenced spinning on the floor of the cage with many interruptions and uncertainly. At 6.55 she commenced again in a corner of the cage, brushing her spinnerets over the floor and the wall, and turning her body sometimes from right to left and sometimes in the reverse direction. Gradually her spinning became more regular, with fewer pauses, and she constructed a nearly circular sheet of close web elevated from the floor to the wall and with a central depression extending to the floor. Up to 7.37 she spun upon this foundation the base of the cocoon, a white, circular disk a little less in diameter than the length of her body, this base (like the supporting scaffolding) rising from the floor to the wall at an angle of 30°. Then from 7.37 to 7.54 she occupied herself

with making a marginal wall upon the base, and did this by laying down looped threads (made by high strokes of the spinnerets); the maximum height of this wall about equaled the diameter of her abdomen, and it was not quite vertical, but inclined slightly toward the centre. She then stood over the base with her head toward its highest margin, and from 7.54 to 7.57 oviposited upon its centre; from her genital aperture fell first a large drop of clear, viscid substance, then a smaller drop containing one ovum, then a large drop into which fell in rapid succession 17 ova; finally a slowly-exuding, thread-like stream of the viscid substance, contained in which were ova arranged one behind the other. All this fluid substance was kept from overflowing the base by the marginal wall. Next, from 7.57 to 8.12, she spun a cover over the egg mass, plastering thread after thread upon it; the cover was of less diameter than the base. From 8.12½ to 8.17 she bit loose the margin of the cocoon, and when a cut had been made pried up the edge with her palpi. The loosened cocoon was now of a lenticular shape, and she took it below her thorax (not holding it off the ground, it was too large for that), and revolved it in that position with her palpi, chelicera and third pair of legs; she spun vigorously upon it so that it soon assumed the definite globular form, and only a line around it marked the point of union of the cover to the base. The cocoon was at first white, but became bluish on contact with water.

The other cocoons made resulted in failures, though the commencement in each of the two cases observed was normal. Thus ♀ No. 196, in making her second cocoon, spun the circular base, built a marginal wall (of a height of 2 mm.) upon it, oviposited upon it from 8.17 to 8.20 (71 ova dropping in succession into one large drop of viscid substance), and spun the cover from 8.20 to 8.24. Then she changed the normal process, and for a minute stopped to loosen a portion of the cocoon from the ground, then spun upon the cover again from 8.27 to 8.34. She then took the cocoon beneath her body and began spinning upon it, but the covering had been made too thin; she was evidently puzzled by feeling the ova through it, and worked hesitatingly; she hung the misshapen cocoon to her spinnerets, but before next morning had devoured it and the enclosed ova. She had not been able to compensate for the initial mistake of spinning too thin a cover. ♀ No. 268 started to spin upon a drop of water that I placed on the floor of the cage; I drained off the water and she ceased. Next day I put in another drop; she first spun over it, then oviposited on it, but the water caused the ova to disintegrate and she finished by eating them.

The water evidently instigated her to the cocooning, yet in natural conditions these spiders do not appear at all aquatic, for I have found them on rather dry ground under stones and logs.

The number of cocoons made, and the dates, were as follows:

(1) ♀ No. 183: June 11, hatched July 5.

(2) ♀ No. 193: July 25, a failure.

(3) ♀ No. 196: June 14, hatched July 10; July 2, a failure. Two cocoons.

(4) ♀ No. 197: June 12, dropped by the mother and did not hatch; July 13, dropped also after the mother had bitten it open prematurely; August 10, dropped August 30. Three cocoons.

(5) ♀ No. 203 was caught with a cocoon that hatched July 1.

(6) ♀ No. 214 was caught with a cocoon that hatched July 5.

(7) ♀ No. 268: July 20, a failure.

Care of the Young.—As in other species of the genus, the cocoon is carried by the mother attached to the spinnerets, and she bites it open to allow the young to emerge, when they get upon her body, and about a day afterward she drops the cocoon. Sometimes, as the above list of cases shows, the mother drops the cocoon before it hatches; in all such cases this appears to be due to the mother biting open the cocoon prematurely, and true to her instinct she drops the cocoon after opening it; when the cocoon is opened too early, the ova do not develop further. The mother is very tenacious of the cocoon. I have seized a cocoon, when attached to the mother, with forceps and shaken it, with the mother, violently in the air, without dislodging her hold upon it; there is, in the case of older cocoons, a very hard and thick thread attaching them to the spinnerets. One mother I watched when she was bending down to drink; about half of the young upon her climbed down to the water and drank of it also, but quickly returned to her when she commenced to move away. In changing this mother from one cage to another, a great mass of young was dislodged from her back and fell upon the floor. Some of these young ran about and would not return to the mother when they came in contact with her, but the remainder clung together in a mass upon the floor. The mother seemed excited, yet when she touched the mass of young she would remain by it only a short extent of time, and did not aid the young to return to her. But next day all were upon her back again.

Lycosa verisimilis Montg.

Parasites.—The type specimen of the female of this species was kept alive some time, until she was killed by the escape of a large species of *Mermis*. Three days preceding she dropped the large globular co-

coon that she was carrying attached to her spinnerets, and 6 parasitic wingless hymenoptera emerged from two circular holes in the cocoon; they had killed all the young spiders that had been contained in it. Prof. William H. Ashmead, Assistant Curator in the U. S. National Museum, kindly identified this parasite as *Pezomachus dimidiatus* Cresson (an Ichneumonid).[2]

Lycosa charonoides Montg.

Care of the Young.—The type individual of this species was caught May 31 with a globular cocoon hung to her spinnerets; the cocoon was apparently newly made because it was light in color, and on the evening of the same day she held it below her and spun upon it in the manner characteristic of the genus. On June 15 I found the cocoon lying on the floor, with a hole made by the mother along about a third of the equator; within the cocoon were about 20 dead spiderlings, while a number of living ones were clustered upon her abdomen and one or two running upon the floor; the young left her back gradually, some remaining upon her until June 26.

Pardosa nigropalpis Emerton. Pl. V, figs. 8, 9.

Individuals observed, males: No. 32, captured May 4, died next day; No. 35, captured May 4, killed May 15; No. 38, captured May 5, died May 29; No. 55, captured May 6, died May 15; No. 56, captured May 6, escaped May 12; No. 59, captured May 6, killed May 19; No. 60, captured May 6, escaped May 18; No. 62, captured May 6, killed May 11; No. 64, captured May 6, died (from thirst) June 5; No. 172, captured June 1, died June 11.

Individuals observed, females: No. 33, captured May 4, died August 15; No. 54, captured May 6, died August 15; No. 57, captured May 6, still living; No. 58, captured May 6, died August 9; No. 61, captured May 6, died June 14; No. 63, captured May 6, died August 15; No. 65, captured May 6, died August 15; No. 152, captured May 26, died (from effects of parasitic *Mermis*) June 11; No. 177, captured June 1, escaped August 9.

Mating.—This was studied by placing a male with a female only during the time of observation, keeping them separated at other times; a partition cage was used, or else the male was carefully dropped into the cage of the female.

This is the most abundant local Lycosid, and by collecting vigorous individuals in the spring, when the males are very numerous, and selecting those females which are not gravid, the courtship may be readily observed.

[2] Prof. Ashmead, in a personal communication, states that a considerable number of parasitic hymenoptera have been reared from the eggs and cocoons of spiders, and names the genera *Bæus*, *Acolus*, *Acolvides*, *Polysphincta*, *Epiurus*, *Pimpla*.

The advances are made by the male, and there is a distinct courtship process, which a vigorous male may maintain for two or three hours at a time with few interruptions when the female is recalcitrant. In natural conditions a large number of individuals often occur together on a limited area of ground, such as a moist open spot in a meadow; here probably the male does not make so prolonged a courtship, but on finding one female not eager or aggressive he probably seeks another. The males are somewhat smaller than the females and considerably weaker, but they are also quicker, so that they can generally escape from an aggressive female. There is a marked sexual color difference, the male being deep black and the female more brownish. Gravid females are always hostile to males, and once that such a female has made a determined rush at a male he usually ceases to court her, or when he recommences does so hesitatingly. The male recognizes a female as such immediately on touch; whether he recognizes her by sight alone I cannot tell. In courting a fleeing female the male appears to follow her mainly by sight, but even then he does not appear to find her by sight unless she is moving; often in his excited march for her he will run right past her without seeing her. But when one of his legs touches a part of her, he immediately reacts by quickly moving back a short distance and, after a brief interval, commences his courting motions with great vigor. These motions he will also continue sometimes for a considerable period after the female has been removed from the cage. In a double cage with a transparent glass partition, a male in one compartment and a female in the other, I have not seen a male court a female, though he certainly sees her through the partition; probably, then, it is touch of a female that impels him to courting activity.

The courtship motions are as follows: The male stands with his body well elevated above the ground (an attitude that a female takes only when she is aggressive) on his three posterior pairs of legs, his head higher than his abdomen, so that the long axis of his body describes an angle of 30°–40° with the surface of the ground. He waves his palp upward in the air (*i.e.*, straightening them out before his head) and flexes them outward, from one to three times, then draws his body slightly backward and downward, rapidly waving in the air the outstretched palpi and first pair of legs, and spasmodically shaking the whole body with the violence of the movement. The vehemence and to some extent the attitudes reminds one forcibly of a small terrier barking at a cat. The movement of the palpi exhibits most clearly their relatively huge, black terminal joints. When the male

is timid, or not very eager, he may wave only his palpi, and these slowly and alternately instead of together. The male repeats these motions several times, usually becoming more vehement each time, then moves a step nearer the female, repeats them again, moves nearer again, so that in a short time his outstretched shaking fore-legs come in contact with the female. A virgin female usually flees before him before accepting him, he eagerly following and repeating his motions, even when he is not facing her. A female who has been fertilized and is pregnant, first menaces him by slowly uplifting and straightening out her first pair of legs toward him; and if this does not suffice to make him desist, she jumps at him when he comes too close. In the latter case the male frequently escapes by leaping over the female. The male seems the very incarnation of violent passion, and his whole body shakes with it; only when the female is so aggressive as to shake him, does he show distinct fear and cease his motions; and if a male has been so cowed by a female, and is immediately placed with another female, he will at first avoid the latter also, this being a good example of memory.

The following data will show the length of time of such courtship, the male in each case having been removed from the female at the end of the period of observation, and it being understood that copulations were enacted only when stated.

♀ No. 33. Put in ♂ No. 32 for nearly two hours on May 4, no courtship. ♂ No. 38 for an hour next day, no courtship. ♂ No. 38 in the evening of May 5, courtship for one hour. May 6, ♂ No. 38, courtship for half an hour in the morning, but none in the evening. ♂ No. 38, courtship of one hour on May 7. The same ♂ would not court on the following day, though she walked over him twice (evidently an invitation to copulation); immediately afterward ♂ No. 35 was put in and courted for half an hour, then repeated it at intervals. May 11, ♂ No. 35 was put in for the whole evening, but there was no courtship, although she displayed no hostility; nor would he court on May 12. On May 12 ♂ No. 64 courted with few interruptions from 1.40 to 3.00 P.M., and from 4.00 to 4.35. May 13 and 14 ♂ No. 64 courted intermittently. May 15 he courted actively from 8.00 to 10.15 P.M., again on May 16 from 3.00 to 6.00 P.M., on May 17 from 7.20 to 10.00 P.M., on May 18 from 7.00 to 10.00 P.M., on May 19 from 2.00 to 4.00 P.M. and from 8.15 to 11.15 P.M., on May 24 for two hours in the morning, on May 25 two hours in the afternoon, May 28 for about an hour, May 31 for more than an hour. After that this female became still more aggressive, and made her cocoon on June 10; she had evidently been fertilized before her capture.

Data could also be given, and I have them in full, for the other females kept, but this case is sufficient to show the persistence of the male in his courtship, and the preference of the female for particular males.

The process of copulation was seen only twice, namely ♀ No. 63 with ♂♂ Nos. 62 and 173. May 8 I placed ♂ No. 63 in her cage at 5.00 P.M., and at 5.15 he commenced his courtship and continued it until 6.00, pursuing her about. About 6.05 they came face to face, and remained so motionless until 6.24. Then he slowly reached out his first pair of legs and touched her abdomen, when she depressed her body to the floor (otherwise in her usual attitude); he walked over her head from in front and took a position upon her so that his head was pointed in the reverse direction of hers, his chelicera immediately above the pedicel of her abdomen, while the pedicel of his was above her head. The female with her head almost touching the floor, abdomen slightly deflected upward, and legs flexed rather closely to the body; the male embracing her closely around the cephalothorax with his second and third pairs of legs, the feet of the other pairs resting on the ground. This embrace was maintained and the female remained motionless through the whole process, from 6.25 to 6.34. The palpi were applied to the epigynum one at a time, as follows: The long axis of the male made a small angle with that of the female (both seen directly from above), so that his head region came to lie a little to one side of as well as above the pedicel of her abdomen. When his left side was thus turned toward the left side of her body, both his palpi were thrown over on that side of her also, but only the left palpus (the one closest to her) was applied; when his right side was inclined toward her right side, both his palpi were also placed on that side of her, but only the right one applied. When he used the right palpus she flexed her abdomen on its long axis so as to bring the right epigynal aperture more dorsal; when he used the left palpus, she would similarly flex the left side of her abdomen dorsad. One palpus would be applied to the epigynum several times in succession, after each application being withdrawn and worked with his chelicera; then the other palpus would be similarly used, after he had inclined his body toward her other side. The palpi were thus alternated several times. At 6.34 the female rose suddenly, assumed a hostile attitude, and the male ran off.

On June 1 I introduced ♂ No. 173 at 2.38 P.M. to the same female. He started immediately to court; she for a minute held her first pair of legs elevated in the air (attitude of guard and hostility), then de-

pressed them and also bent her head to the floor (copulation attitude), but he discontinued courtship, and she moved away. At 2.42 he courted again, and she again depressed her head to the ground (her fourth pair of legs stretched out behind her, her other legs flexed to her sides) at a distance of half an inch from him; he then faced her for two minutes without courting, but he recommenced his courting at 2.44, and at 2.45 walked upon and embraced her, in the attitude previously described. The left palpus was then applied to the epigynum 6 times from 2.45 to 2.46, then the right palpus (on the right side of her body) 18 times from 2.46 to 2.52½. On each application the palpus was first rubbed against her epigynum, and when inserted a large clear sac, an evaginated portion of the palpus, swelled up and slowly (in 20 to 25 seconds) collapsed; after its collapse he withdrew the palpus and rubbed it against his chelicera for 2 or 3 seconds, then applied it again to the epigynum. At 2.52½ the female rose quickly, shook him off, and stood in hostile attitude, repelling several further attempts to copulate. No oviposition intervened between these two acts of copulation.

Cocooning.—This process was observed several times. In captivity it takes place at night, generally in the hours between 9.00 P.M. and midnight; though the earliest preliminary spinning frequently begins some 24 or more hours before. The following case is a good illustration of the method as observed in glass cages without earth:

♀ No. 54, on May 19, at 9.20 P.M., was first seen to be spinning, fastening threads (inclined at an angle of about 45°) from one vertical wall to the floor, and from the opposite vertical wall to the floor; at each wall was then a line of such parallel threads about a quarter of an inch long. This was a rather slow process, she taking often several seconds to attach each thread, and sometimes pausing to rest for a quarter of a minute. At 9.50 she started spinning the base of the cocoon on the scaffolding of lines placed against the right wall, not again returning to that on the left wall. The circular disk constituting the "base" of the cocoon was made by spinning upon a circular area of the scaffolding, at about the middle level of the latter; it was made discoidal in form by the female pressing the tips of her palpi upon one edge of the area, spinning upon the opposite edge, then rotating her body on its middle point as an axis. This was first done very slowly, but at 9.59 she began spinning more regularly, brushing her spinnerets (without elevating them) back and forth over the area, at the same time rotating her body, so that gradually a well-marked white disk was laid down upon the scaffolding, its

diameter not quite equalling the length of her body; the scaffolding around the disk served as a support for her feet. The making of this base continued until 10.24. Then she stood above it with her head directed toward its upper end, and deposited upon the centre of the base from her genital aperture a large viscid drop of a transparent fluid; and into this drop, the upper surface of which still adhered to her body while its lower surface rested on the silken disk, there fell in succession about 13 large ova, easily seen by their yellow color within the viscid drop. This discharge of drop and ova did not exceed two minutes. Then at 10.26, before the upper surface of the drop had become fully loosened from her genital aperture, she commenced rapidly spinning across the drop, brushing the spinnerets from side to side and occasionally rotating the position of the body until she covered it with an evenly thick coating of white silk. This coating compressed the drop to the form of a flattened hemisphere; the supporting base being still flat, and quite a broad margin of it not covered by the upper covering of the cocoon. At 10.40 she commenced to bite the cocoon loose from the scaffolding, taking about 4 minutes in the process; when completely loosened it had the form of a biconvex lens. She then seized and held it beneath her cephalothorax with her third pair of legs, which like a pair of axles were first applied to its rounded sides, and revolved it by pressing on its edge with her palpi. While doing so, she held her abdomen bent vertically downward, so as to bring the spinnerets against the edge (equator) of the cocoon, and by spinning cemented down the overlapping margin of the base of the cocoon to its cover; it will be recalled that the covering of the cocoon was of less diameter than the base. Gradually and slowly the cocoon was rotated in other directions also, still held below the cephalothorax above the floor, the extended spinnerets brushing back and forth across its surface. At 10.50 the cocoon was observed to have changed from a glistening white to a lead-blue color (its final color is dark blue or dark gray); this may be produced by a difference in the silk, or perhaps by a secretion from the mouth. At 11.12, when I ceased observations, she was still busy spinning upon the cocoon. It had now become much more nearly globular, the definitive shape, and trace of a line around its greatest diameter was all left to show that it had been formed of two halves cemented together.

The first cocoon of ♀ No. 57 was made on May 12. At 4.50 P.M. she was found working upon the discoidal base (there had been no trace of it less than an hour before), and continued until 5.06. Then

followed the oviposition, lasting not quite 2 minutes, in exactly the same manner as in the preceding case, except that 33 or 34 ova were discharged into the viscid drop. The ova sank one by one into this drop so as gradually to fill it and increase its size, but by virtue of its viscidity it still retained its globular form and surrounded them all. At 5.08 she started spinning the cover, finished it at 5.20, and in the time from 5.21 to 5.25 cut the cocoon loose from its scaffolding by tearing the surrounding threads with her chelicera. She then brought the cocoon below her cephalothorax and spun upon it; at 5.28 suspended it from her spinnerets and ran about, and at 5.34 spun upon it again. The fact that her cage had been kept in a dark drawer might account for the cocooning in the afternoon. For her second cocoon (finished July 3) she commenced the scaffolding on July 2. On July 3, at 9.50 P.M., I found her in process of finishing the circular base, and here I observed an action that I had probably overlooked in the case of the other cocoons; when the white discoidal base was clearly outlined upon the scaffolding she spun, upon its margin only, long curled threads, each made by attaching her spinnerets to one point of the margin, then elevating them and attaching them again close to the first point of attachment; thus she made a marginal wall, just sufficiently elevated to be seen with the naked eye. From 10.01 to 10.06 she worked upon this wall. Then the oviposition followed upon the centre of the base from 10.07 to 10.10½. From then until 10.20 she started covering the egg mass with high upliftings of the spinnerets, thus laying down loops of threads, and from 10.20 to 10.24 with brushing movements of the spinnerets. From 10.24 to 10.26½ she occupied herself in biting the cocoon loose. Then she held the cocoon below her and spun upon it until 11.07, when she attached it to her spinnerets.

♀ No. 63 I found at 7.15 P.M., June 7, laying the covering upon the egg mass. She cut the cocoon loose at 7.23, at 7.24 walked about with it attached to her spinnerets, but at 7.26 held it below her again and spun upon it until 7.59. At 8.04 she attached it to her spinnerets again for a couple of minutes, then commenced to spin upon it again.

♀ No. 61 was unsuccessful in her cocooning; at 10.30 P.M., May 11, I found her holding beneath her cephalothorax a misshapen object, bowl-shaped and of a bluish color, evidently a miscarried cocoon; she tried in vain for a long time to spin upon it, and finally dropped it.

Thus the nearly globular cocoon is formed from two separate pieces.

The number of cocoons, and the dates of their making, were as follows:

(1) ♀ No. 33: June 10 (did not hatch as it had not been cut).

(2) ♀ No. 54: May 19, hatched June 7; a second cocoon hatched July 9.

(3) ♀ No. 57: May 12, hatched June 2; July 2, hatched July 19.

(4) ♀ No. 61: May 9, an abnormal cocoon.

(5) ♀ No. 63: June 7, she cut it open but the young never hatched, for she had probably opened it too soon; July 25, an irregularly shaped cocoon, which she destroyed by chewing on the same day.

(6) ♀ No. 65: May 9, hatched June 1; June 10 or 11, hatched July 1.

(7) ♀ No. 58: May 18, hatched June 7; July 12, a very small cocoon which she ate.

(8) ♀ No. 177: June 4, eaten by the mother; June 29, eaten by the mother.

Thus none of my captives made more than two cocoons.

Care of the Young.—The cocoons are carried suspended from the spinnerets, and generally kept well elevated above the ground, the spinnerets being firmly fastened to one of the rounded sides. The mother bites open the cocoon to allow the escape of the young, and unless it is so opened the young cannot get out of it. This biting of the cocoon was observed in several individuals; sometimes it lasts through several days, for only a short time each day; in one case the mother started to cut the cocoon a full week before the young emerged; the following is a typical case: ♀ No. 65 on May 30 was first observed cutting her cocoon. On May 31, at 9.10 P.M., she was cutting it again. The cocoon was held beneath her cephalothorax by the first and third pairs of legs and by the abdomen deflected downward, in such a position that the plane of its largest circumference (its equator) coincided with her median plane. With her chelicera she slowly tore away the thick outer covering along the line of the equator, her palpi aiding, and at the same time her legs slowly rotated the cocoon. This cutting is not a continuous process, but interrupted by frequent short rests as if she were noticing movements of the young. At 10.22 she suspended the cocoon from her spinnerets, and cut again from 10.35 to 10.39. The cut was now very deep, so that through it the spiderlings could be seen moving within the cocoon. Next morning several of the young had crawled out upon her body, and at midday she finally dropped the cocoon, although there were still young within it. Some mothers open their cocoons with a cut extend-

ing along almost the whole line of the equator, and once the young are upon her she pays no more attention to the discarded cocoon. It is interesting to note (and this is also the case in the other Lycosids examined by me, perhaps with the exception of *Ocyale*) that the cocoon is always cut open along the line where the cover had previously been cemented to the base of the cocoon; this equatorial line is always a little rougher than the remaining surface of the cocoon, and perhaps this roughness impels her to a further roughening.

The young, on emerging from the cocoon, hang on to the body of the mother for some time before leaving her, and leave in succession, the more vigorous first. ♀ No. 54 carried her young from June 7 to June 13; ♀ No. 57 from June 2 to June 9; ♀ No. 58 from June 7 to June 12; ♀ No. 65 from June 1 to June 3. Thus in the observed cases the time varies from 2 to 7 days.

Feeding.—As in other Lycosids this species kills the prey by grasping and biting it, and rarely accepts dead insects; and not only sucks the juices of the victim but chews it up. It also drinks water frequently.

Parasites.—Two large individuals of a species of *Mermis* (Nematode) escaped from ♀ No. 152.

Pardosa scita Montg.

This species is much less abundant than *P. nigripalpis*, but still fairly common on some dry, open grounds. It runs and leaps very rapidly, and is difficult to catch. I have made but few observations upon it.

Moult.—As in other Lycosids.

Mating.—Only once was the beginning of a courtship seen. The male touched the female, then waved his palpi in the air in the manner of *P. nigripalpis*, but for only a few seconds, and did not repeat the movement. Afterward whenever he approached her, she would wave her first pair of legs in the air and tap his with hers.

Parasites.—A species of *Mermis*.

Pirata liber Montg.

This is the common local species of the genus, and frequents marshy ground. It dies very quickly from thirst and is with difficulty kept alive in confinement. A number of individuals were watched, but the following were the only observations worth recording.

Mating.—A male placed in the cage of the female touched her, went off, then returning with his first pair of legs outstretched and in tremulous vibration he touched her with them, when she jumped

at him. This might have been a courting movement on the part of the male, or else a cautious reconnaissance.

Cocooning.—On June 2, at 1.30 P.M., I found a female had spun a scaffolding of silk threads from the floor to the wall of the cage, and upon it a circular disk of white silk; the latter was evidently the base of the cocoon. I unfortunatelv placed a drop of water near her on the glass floor of the cage. She then left the cocoon base, spun upon the surface of the water drop, evidently mistaking it for the silken base, and ultimately oviposited upon it. Later she raised and held the egg mass beneath her cephalothorax, holding it there with her palpi, chelicera, third pair of legs, and with her abdomen bent vertically downward, and endeavored to spin upon it in that position. But there was only a thin covering of silk on only one surface of the egg mass, the cocoon came to grief, and she ultimately ate it up. The drop of water had disturbed the regular course of the cocooning. In the state of nature this species carries its round cocoon attached to the spinnerets.

Ocyale undata (Hentz). Pl. IV, fig. 1.

Care for the Young.—This species, as Hentz and Emerton have described, constructs a web-nest for its young in the top of small plants. I kept several females in order to learn this habit more in detail, and the following notes relate to ♀ No. 235, captured June 22.

This spider was caught upon the ground in a wood, laboriously moving along with its large spherical cocoon. Then, and for the first evening after her capture, she held her cocoon beneath her body with the aid of her chelicera, palpi and with her abdomen pressed against it; but unlike other Lycosids, her spinnerets were not attached to it. That night she spun a network of lines in the cage, and next morning was hanging upside down, hanging to the web lines with the claws of her first and fourth pairs of legs, tightly embracing the cocoon with her other legs, her chelicera and her palpi, in the position shown by the sketch. Only once up to the time of hatching did she leave the cocoon hanging in the web, and then in order to clean herself; at all other times she continued to hold it tightly, and refused flies and beetles put in as food. She occasionally climbed about with the cocoon, spinning new lines in the cage, until quite a thick network was made; and on July 9 I found the cocoon, bitten open by the mother, hung high in the web, and numerous newly hatched spiderlings distributed over the web. She spun so many new lines that she herself finally became enmeshed in them, and on July 18 I cleared them

away. On the early morning of July 22 she made a second cocoon, when there were no nest lines in the cage; on August 9 she fastened it to the roof of the cage, cut it open with her jaws so that the young emerged, and in the succeeding days built a web-nest around it.

From these few observations we may conclude that the cocoon is made first, that the mother most carefully holds it until the time for hatching, when she cuts it open and then spins the web-nest around it. This method of holding the cocoon, and of guarding the young upon a nest instead of carrying upon her body, is shared by our local *Dolomedes urinator* Hentz, but is different from the usage of the other Lycosid genera. These web-nests are generally found on the top of plants along the sides of wooded streams, and have a decided resemblance to the nests of Lepidopterous larvæ.

Tegenaria derhami Scop.

Individuals observed, males: No. 23, captured May 2, escaped May 22; No. 74, captured May 13, died (from starvation) June 5; No. 80, captured May 14, killed May 27; No. 178, captured June 5, died July 24; No. 218, captured June 19, died about September 1; No 221, captured June 19, died July 8; No. 252, captured June 26, killed (by ♀ No. 25) the same day.

Individuals observed, females: No. 22, captured May 2, died May 21; No. 25, captured May 2, died August 4; No. 75, captured May 13, died August 19; No. 79, captured May 14, died September 1; No. 84, captured May 15, killed May 25; No. 117, captured May 24, died about September 10; No. 118, captured May 24, escaped June 5; No. 219, captured June 19, died in December; No. 220, captured June 19, died the first week of September.

Moulting.—This was seen only once; the moulted skin was split in the horizontal plane as in other spiders.

Mating.—The mode of observation was to put a male upon the web of the female, and the male was in most cases left with her and not removed, since removal would necessitate a breaking of the web. The male is of about the same size and strength as the female, and the two generally live peacefully together. Sometimes the male is the more aggressive and secures all the food placed in the cage, but more generally the female lords it a little over the male. The following are my main observations on the approach of the male and the mode of copulation:

(1) On to the web of ♀ No. 22 I placed ♂ No. 23 on May 3, at 2.41 P.M. They touched each other a few times, then remained motionless facing each other from 2.49 to 3.02. Then she moved toward him and followed him slowly, she finally touched him and he moved away. Then both remained immovable until 4.00, when I removed him. On May 3 I put him in again at 9.15 P.M.; he touched her,

she instantly turned and faced him, their fore-legs almost in contact. They remained in this position until 9.29, he tapping the web a few times with his palpi, while she shook the web vigorously with her left fore-leg for a couple of seconds. At 9.30 he rubbed his palpi vigorously with his fore-legs, then approached and copulated, this act lasting only 5 seconds. Their exact position in the act was not determined. I could only observe that he approached head on with one palpus outstretched, they mutually grasping each other with their first pair of legs, both in their usual position on the upper surface of the web. She then moved away. At 9.35 he walked over her without copulating. At 10.25 she approached and tapped him several times with her left fore-leg, and again at 11.02. I watched them continuously up to 12.27, then left him with her. Up to May 21, when she died (he securing most of the food given them), I watched them many times, saw him on some occasions approaching her with shaking palpi, but observed no further copulation.

(2) To ♀ No. 25, after she had made 3 cocoons, I introduced ♂ No. 225; she chased and killed him.

(3) ♀ No. 79 had made 3 cocoons, when ♂ No. 178 was introduced on June 19, at 9.15 P.M. He moved toward her very slowly, a step of a centimeter each time, slowly and cautiously tapping the web with his palpi; he took about 9 minutes to cross a distance of 2 inches, and then when he had almost reached her, she rushed at him and drove him away. At 9.35 he again approached cautiously, and at 9.50 rushed at her, but she repelled him. At 9.57 he advanced again, at 10.10 making a quick rush at her and almost succeeding in inserting an extended palpus in her epigynum, but she escaped from him. No copulation was seen up to 11.25.

(4) ♀ No. 117 made her first cocoon on June 10. On June 19, at 9.40, ♂ No. 221 was placed on her web. At first she chased him about, then both became quiet. At 10.01 he quickly ran at her, and copulated with his right palpus from 10.02 to 10.03, for ten minutes after which she chased him about the cage. The copulatory position was the same as that of ♀ No. 75 × ♂ No. 218.

(5) ♀ No. 75, after making 2 cocoons, mated with ♂ No. 218 on June 19. He was introduced at 9.08 P.M., and shortly after she chased him. At 10.00 he made a sudden move toward her and succeeded in copulation; he inserted his right palpus into her epigynum for 1 minute, his left for 15 seconds, his right again for a minute and a half. Position: the male braced himself firmly on all legs upon the web, and reached his palpus straight out before him and pressed it into the

epigynum with considerable energy; the female faced him also on the upper surface of the web (just within the funnel), lying partly on one side with her legs drawn up, but not closely, to the sides of her body. During the act the male pushed the female backward by his force. When the palpus was inserted there was seen a large dilated sac evaginated from the palpal organ. The female then ran off, and the male proceeded to the process of sperm-induction.

In these copulations the male accordingly first approaches slowly, the female also sometimes making advances on her part, and concludes with a rush at the female, and if he is quicker than she he succeeds in inserting his palpus. The fact that females copulate after cocooning makes it appear probable that a copulation may precede the making of each cocoon.

Sperm-induction.—♂ No. 218 was watched during this act, which occurred immediately after his copulation with ♀ No. 75 (concluded at 10.03 P.M.). He first spun across an area of nearly a square inch on the upper surface of the web, then limited himself to a small area just at the entrance of the tunnel of the web. Here, by very rapid brushing of the spinnerets from side to side, he constructed a delicate silk sheeting placed at an acute angle to the surface of the nearly horizontal web, the posterior and lateral edges of this sheeting attached to the web, but its anterior edge unattached and elevated like an arch. From side to side this sheeting was not quite so long as the length of his body, and half this distance from before backward. He then stood over it, so that the ventral surface of his abdomen almost touched the superior surface of the sheeting, his cephalothorax above the anterior (free) edge of it, and his spinnerets at its posterior edge. At 10.21½ P.M. he moved his abdomen slightly forward, discharged from his genital aperture a minute drop of sperm upon the superior surface of the sheeting at its free edge, and from that moment until 10.28 he was engaged in taking this sperm into his palpal organs. This he did by pressing the ventral (posterior) surface of each palpal organ on the under surface of the sheeting, just at the point where the drop of sperm had been placed on its upper surface; one palpus he held thus, with occasional shaking, for 10 to 15 seconds, then the other, until the whole of the drop was inducted; and each palpus when not so busied he held in front of his cephalothorax and shook it in the air, as if to force the semen deeper into the organ. From 10.27 until 10.34, just after the completion of this process, he remained in the same position, but quietly and with no further discharge of semen upon the sheeting. Then he left the sheeting, worked his palpi a short while

with his chelicera, then remained quiet until 11.10 when I ceased the observations. The spirit is always willing to watch longer, but continuous observation with a hand lens, and the necessity of keeping quiet in a cramped position for fear of startling the object, becomes trying to the flesh.

A curious act which I observed ♂ No. 23 to do I cannot explain, but it may possibly have some connection with the mating. On May 3 he was upon the web of ♀ No. 22. At 9.50 P.M., after his copulation with her (described above), he commenced to tear a hole in the horizontal portion of her web, tearing with his palpi and putting the torn shreds in his jaws. He thus made an oblong rectangular hole of about the length of his body, and as he continued to tear the portion just in front of him, he swung his spinnerets over the posterior part of the hole, and so spun it over with very fine transverse lines. This act lasted until 10.04, and only about one-quarter of the hole in the web had been mended over. Though I watched him closely up to 12.27 A.M., he did not return to this hole.

Cocooning.—This was observed several times, and was as follows:

♀ No. 79 was observed at 8.00 A.M., June 19, spinning over a circular area (of greater diameter than her own length) on the vertical glass wall just above the edge of the web. She ceased until 8.09, owing to a jar to the cage, then commenced again. Very regularly and actively, without interruption, she spun up to 8.23, placing her feet at the periphery of the silken disk ("base" of the cocoon), and revolving her body over it, turning sometimes from right to left and sometimes in the reverse direction, all the while beating the tips of her palpi upon the disk. During the earlier part of the process the outstretched spinnerets were brushed from side to side; but in the latter part she lifted the abdomen high after each application, thus pulling out long threads which she fastened close to their first point of attachment, so that the inmost (most lately made) part of the disk was made of curled loops, and so was of very soft consistency. Thus the base of the cocoon, somewhat thickest in the centre, was formed. At 8.23 she stood quietly over this base, then oviposited upon it, the oviposition lasting a little more than one minute. From her genital aperture exuded a large clear drop of viscid fluid and fell upon the centre of the base, its upper surface still connected with her genital aperture, and at the same time the yellowish ova fell into and were enveloped by this drop. Then she immediately began spinning the cover of the cocoon over the egg mass. From 8.24½ to 8.35 she spun a loose covering of silken loops by elevating the spinnerets after each

application (just as in the making of the base), and from 8.35 to 8.44 she spun a denser covering by brushing the spinnerets from side to side. Finally she alternated the spinning upon the cocoon itself, with spinning attachment lines from it to web.

♀ No. 25 made her first cocoon on the horizontal surface of her web, apparently not spinning a special base.

♀ No. 75 made her second cocoon upon the surface of the web, and after spinning a discoidal base oviposited upon it at 7.41 A.M.; she occupied the time from 7.42 to 8.00 in spinning the cover.

♀ No. 220 spun her cocoon in the same manner as did No. 79.

One female, after making her cocoon at the angle of the wall and floor of the cage, spun over it several thin, concentric, arched lamellæ of silk, evidently a protection. In a few cases the female attaches foreign particles, as the remains of insects, to the surface of the cocoons, but this was not done with the majority of the cocoons. The cocoons, even those of the same spider, are placed in most diverse positions, some horizontally and some vertically, some upon the web and some away from it.

The number of cocoons made and the dates of construction were as follows:

(1) ♀ No. 25: May 31 (hatched June 9); May 29; June 10 or 11 (hatched July 5); June 20 (hatched July 16); July 2 (did not hatch); July 9 (hatched July 31); July 21 (not all the eggs hatched); August 1 (hatched). A total of 8 cocoons made by an unusually small female.

(2) ♀ No. 75: May 23 (hatched June 14); June 7 (destroyed by the mother); July 5 (hatched July 30); July 17 (hatched August 2). A total of 5 cocoons.

(3) ♀ No. 79: May 24 (hatched June 19); June 7 (hatched July 5); June 19 (hatched July 12); June 29 (hatched July 19); July 7 (did not hatch); July 17 (hatched August 9); August 1 (hatched); August 21 (hatched). A total of 8 cocoons.

(4) ♀ No. 117: June 10 (hatched July 6); June 26 (none of the ova developed); July 3 (hatched July 23); July 12 (hatched July 29); July 27 (hatched August 20); August 8 (hatched); August 28 (hatched September 29). A total of 7 cocoons.

(5) ♀ No. 118: May 31 (hatched June 5).

(6) ♀ No. 219: July 4 (hatched July 24); July 28 (hatched August 21); August 21 (hatched). A total of 3 cocoons.

(7) ♀ No. 220: June 29 (hatched July 27); July 16 (hatched August 2); July 30 (hatched August 22); August 21 (hatched). A total of 4 cocoons.

The differences in the time of hatching are probably due as much to differences in the thickness of the cocoons as to any such factor as temperature.

Care of the Young.—I have seen no evidences that the mother guards in any way either her cocoons or her young. The young make their own way out of the cocoon, making an opening or openings at the margin where the cover is joined to the base; that the mother does not tear the cocoon open for them is proved by the cases where the young emerge at a point that is inaccessible to the mother.

Feeding.—This is rather a timid species, the great protection afforded by the tubular portion of the web compensating for want of strength, and they rarely attack prey as large as themselves, and usually avoid much smaller spiders. The prey is killed by biting, and after being sucked dry is usually left hanging in the web. The males especially are frequently eager for water.

Agalena nævia Walck. Pl. IV, fig. 4.

Individuals observed, males: No. 72, captured May 11, moulted May 24, June 7, July 3, July 28, died September 30 (starvation); No. 303, captured July 9, moulted August 2, killed by ♀ No. 243, August 20.

Individuals observed, females: No. 73, captured May 11, moulted May 13, 25, June 7, 29, July 13, August 5, still living; No. 206, captured June 16, moulted June 29, July 27, died in December; No. 243, captured June 22, moulted July 3, July 28, died in November.

Moult.—The first moult of ♀ No. 73 commenced at 11.08 P.M., she hanging with her spinnerets and feet attached to the roof of the cage. The old skin split into a dorsal and a ventral piece, separated by a horizontal break along the sides of the abdomen, along the sides of the cephalothorax above the legs and below the eyes. She slowly fell out of the split exuvia, with the help of slight convulsive movements of the body and legs. Her legs were completely freed at 11.15, and at 11.23 she hung head down attached to the exuvia only by the spinnerets. At 11.39 she climbed into the web. The new skin is at first much lighter than it becomes on exposure to the air.

Mating.—The two cases seen were these:

(1) ♀ No. 73. ♂ No. 72 was placed upon her web on August 21, at 10.20 A.M. Both were immovable up to 12.00, when I left them. On my return at 12.40 his fore-legs were touching hers. At 12.47 he shook his body. At 1.20 she flexed her legs close to her sides, he being then upon the web half an inch above her. At 1.26 he seized her from above, his head pointing toward her spinnerets, and tapped her abdomen several times with his first pair of legs, she motionless. At 1.36 he left her; she remained inert until 1.46, then moved somewhat,

when he quickly turned and faced her and she became again motionless with her legs flexed closely. At 2.06 he pulled her toward and beneath him, his head facing her spinnerets and just above the pedicel of her abdomen; at 2.08 turned her partially on her side, then applied his left palpus from 2.08 until about 5.00, then applied his right palpus on her other side from 5.00 until 9.40; the number of insertions of each palpus was not noted. At 9.40 he stood over her. At 9.46 she moved slightly for the first time, when he embraced her again and tapped her abdomen rapidly with his fore-legs, got her again into copulatory attitude and inserted his left palpus from 9.50½ to 9.54. He then withdrew this palpus and cleaned it vigorously with his chelicera until 9.58, when he left her. She quickly rose and followed him, but he escaped.

(2) ♀ No. 243. ♂ No. 303 was dropped upon her web on August 19, at 3.14 P.M. At 3.34 he placed his first pair of legs upon hers, while he was higher in the web than she. At 3.37 she turned away, then faced him again, and at 3.40 he moved still nearer. At 3.46 he suddenly grasped her with his legs, and, she flexing her legs to her sides and becoming motionless, he carried her an inch away from the place. At 3.49 he left her still lying inert and walked about, evidently seeking a place on the web favorable for copulation, returning to and standing over her half a minute later. At 3.51½ he seized two of her legs with his chelicera, carried her about, then dropped her. At 3.54 she turned around. At 3.59 he seized her again, placing himself over her with his head directed obliquely toward her spinnerets, she lying partially on one side with her legs flexed, and commenced the copulation with his left palpus. The length of time of each insertion of this palpus was as follows: 3.59–4.19½, 4.20–4.30, 4.31–4.37½, 4.39–4.46½, 4.47–4.56, 4.57–5.03, 5.03¾–5.08½, 5.09–5.14, 5.15–5.22, 5.23–5.31, 5.31¾–5.41½, 5.42½–5.49½, 5.50–5.55, 5.56–6.01, 6.01¾–6.09, 6.09½–6.14, 6.14¾–6.24, 6.24½–6.28, 6.29–6.36, 6.36½–6.56½, 6.57–7.10½, 7.11–7.21, 7.22–7.30½, 7.31–7.40½, 7.41½–7.50½, 7.51–7.58½, 7.59¼–8.06½, 8.07–8.16, 8.17–8.36½, 8.38–8.39, 8.40–8.54. He inserted the palpus each time by extending it downward along the left side of her abdomen to her epigynum, and inserting the spirally wound process of the palpal organ for its whole length; when inserted, a large sac connected with the ventro-median side of the palpal organ swelled up. The palpus was withdrawn after this sac had collapsed, and the palpal organ drawn through the chelicera before the next insertion. At 8.55 the male changed his position upon her, so as to bring his long axis parallel to hers, lifted her 1 cm. backward, then stood quietly over her. At

8.58 he brought his head obliquely over her right side, then applied the right palpus, in the same manner as he had the left, as follows: 8.58½–8.59½, 9.00–9.12, 9.13–9.19, 9.19½–9.24, 9.25–9.30, 9.30¾–9.34½, 9.35–9.39, 9.40–9.45, 9.46–9.49½, 9.50–9.56, 9.56½–10.02, 10.02½–10.06, 10.06⅓–10.16, 10.16½–10.23, 10.23½–10.29½, 10.30½–10.39½, 10.40–10.45, 10.45½–10.55, 10.56–11.18, 11.18½–11.31, 11.32–11.46⅓, 11.47–11.59. Then for very weariness I ceased watching and left them in copula, and next morning found the female eating the male. The female was immovable throughout the whole act, her sternum with its ventral surface downward, but her abdomen twisted on its long axis so as to flex the epigynum up to meet the palpus of the male. His right palpus was used upon her right side, his left palpus upon her left side.

The copulation lasted in the first of these cases for 7 hours and 47 minutes; in the second case it was watched for exactly eight hours, but lasted longer. In both cases the approach and behavior of the males was alike, and both used the left palpus first. There was nothing in the behavior of the males to indicate a courtship; there was simply a cautious approach of the male, and after he had found no sign of hostility on the part of the female he quickly seized her, and she was absolutely submissive in his grasp. When he first grasps her he taps her abdomen with his first pair of legs, perhaps an act of subjugation.

Not one of the females have made cocoons up to the time of this writing (October 5).

Dictyna volupis Keys. Pl. V, fig. 6.

Numbers of individuals of this species were collected on May 26 upon vines of *Ampelopsis* and English ivy growing upon the walls of my old homestead, near West Chester, Pa. They had constructed their webs upon the upper surface of the leaves of these plants, and upon most of the webs a male and female were found together, and a number of these were found then in copulation. This species is easily kept in captivity, and on account of their small size I kept them in test-tubes with the mouth loosely plugged with cotton, placing a male and female together in each tube, when they made the webs conjointly; males and females caught together were kept together.

Individuals observed, males: No. 130, caught on web of ♀ No. 131, died June 15; No. 132, caught on web of ♀ No. 132, died June 24; No. 134, caught on web of ♀ No. 135, died in June; No. 136, caught on web of ♀ No. 137, died June 16; No. 138, caught on web of ♀ No. 139, died June 3; No. 140, caught on web of ♀ No. 141, died June 18; No. 142, caught on web of ♀ No. 143, died July 2; No. 144, caught on web of ♀ No. 145, died June 3; No. 146, caught on web of ♀ No. 147, died in June; No. 148, caught on web of ♀ No. 149, died June 7.

Individuals observed, females: No. 131, escaped June 14; No. 133, escaped

July 2; No. 135, died early in September; No. 137, died early in September; No. 139, escaped June 3; No. 141, died about September 1; No. 143, died August 6; No. 145, still living; No. 147, died about September 28; No. 149, died in September.

Mating.—The following were the observed cases worthy of note:

(1) ♀ No. 133. ♂ No. 132 was introduced at 12.30 P.M., May 27. Most of the time he spent in spinning upon the web, but sometimes approached and touched her, when she either moved away or else shook her legs tremulously. At 3.40 I was obliged to leave, and on my return at 4.33 found them in copula against the bottom of the test-tube. She lay upon her left side with her legs flexed close to her body, her abdomen and cephalothorax in one line. He lay upon his right side with his face pressed against the ventral surface of her cephalothorax and his ventral surface turned toward hers, but not parallel with it, the axes of their abdomens diverging at an angle of more than 45°; his first two pairs of legs embraced hers closely, his posterior pairs were directed backward and braced against the web. This male had lost his right palpus; his left he extended backward along the ventral surface of her abdomen so as to hold the palpal organ inserted in her epigynum. This copulation lasted without interruption up to 5.32. Then after she had made two cocoons, on June 4 and 9 respectively, the same male was found in copulation again at 12.59, continuing so up to 1.48, when he left her, and though he returned several times she met him with open jaws, except once when she approached him with closed jaws, shaking her flexed first pair of legs. Then he proceeded to charge his palpus with sperm.

(2) ♀ No. 135. ♂ No. 134 was found at 7.35 P.M., May 27, in copulation; the embrace was as in the preceding case, except that their bodies were directed upward. Only the right palpus was used, and that was kept continuously inserted; a large evaginated sac connected with this palpal organ dilated and contracted 10–11 times a minute, each dilation of it accompanied by a slight jerk of his abdomen. He suddenly left her at 8.09, worked his palpi through his jaws, shortly after fed upon a gnat, and no further copulation was observed up to 10.20. On June 13, after she had made three cocoons, they were seen again in copulatory attitude, but his palpi were not inserted.

(3) ♀ No. 141. ♂ No. 140 was embracing her at 2.00 P.M., May 31, but his palpi, though pressed against her abdomen, were not inserted. The right palpus was inserted continuously from 2.15 to 3.06. He then moved a few millimeters away, and on approaching her again she rushed at him with opened jaws and chased him the length of the

test-tube. No further copulation was observed up to 4.20. On June 5, at 12.55 P.M., she having made no cocoon in the meantime, they were again copulating, he using his left palpus continuously up to 2.10, then his right from 2.10 to 3.13, after which he ran to the opposite end of the test-tube and cleaned his palpi with his chelicera.

(4) ♀ No. 147. May 26, at 2.00 P.M., ♂ No. 146 approached and seized her, then inserted his left palpus continuously from 2.04 to 3.02, then at 3.02 his right and kept it inserted up to 4.20, when I was obliged to stop observations; they were separated on my return at 5.25.

(5) ♀ No. 149. At 8.14 P.M., I saw ♂ No. 148 come face to face with her, then, each of them tapping upon the web with the first two pairs of legs, they moved backward and forward slowly. This lasted only two minutes, when they both became quiet half an inch apart; it was repeated again for a short period at 8.54. On June 1 they were seen in copulation at 4.52 P.M., he inserting his left palpus, and again on June 4, at 11.35 A.M., continuing up to 11.50, he using his left palpus, and afterward he proceeded to the sperm-induction.

In this species the male is shaped quite different from the female. and is a little larger (an unusual condition among spiders). There is no true courtship on the part of the male, for his tapping upon the web with his fore-legs is an act which the female also does. More than one copulation may precede the making of a cocoon; and copulation may follow cocooning. The longest time a pair was seen in continuous copulation was 2 hours and 18 minutes, the left palpus here being employed for 1 hour and 15 minutes, then the right for 1 hour and 3 minutes.

Sperm-induction.—This was seen twice:

(1) ♂ No. 132 terminated his second copulation with ♀ No. 133 at 1.35 P.M. After that I watched him continuously with a lens. From 2.00 to 2.19 he alternated spinning upon various portions of the web with cleaning his palpi with his chelicera. At 2.20 he commenced spinning over a small area, the diameter of which was not larger than the length of his abdomen, and ceased at 2.22. Half a minute later he bent his abdomen downward and discharged from his genital aperture a minute drop of sperm, which appeared to adhere to the delicate web beneath him, and at the same moment reached his left palpus (his right was missing) downward and backward beneath his cephalothorax and took this drop into the palpal organ. He then remained quiet up to 1.42, when I stopped observations, occasionally shaking his palpus in the air, but discharging no more sperm.

(2) ♂ No. 148, on June 4, ceased his copulation with ♀ No. 149 at 11.50 A.M. About 4 minutes afterward he started spinning on the glass wall, not using his calamistra, and made a close but scarcely visible silk sheeting at one place. This continued up to 12.05 P.M., when he stood over it, shaking his palpi and rubbing them against his chelicera. At 12.10 a minute whitish globule of sperm fell from his genital aperture upon the silk sheeting, rolled forward upon it (*i.e.*, toward his head), and was immediately taken into one of his palpal organs, and that palpus was then shaken repeatedly many times. After that he remained in the same position, flexing his palpi and pressing them against the silk sheeting. But there was no further discharge of semen, though I watched him continuously with a lens. He spun again in another place from 12.20 to 12.27, then went off to feed upon a fly.

The peculiarity of the sperm-induction in this species is its rapidity, and the fact that the palpi are not placed beneath the silk layer made to catch the drop of sperm.

Cocooning.—This process was not seen, most of the cocoons having been made in the early morning. Only the conclusion of it was noticed in a couple of cases, *i.e.*, the finishing of the cover of the cocoon; silk was applied that had been drawn out by the calamistra from the cribrellum. And female No. 131 was seen standing over a flat circular disk of silk one day at 12.00 P.M., and sometime before the next day she oviposited upon it and spun another disk as a cover; this observation shows that this species, as other spiders, makes her cocoon of a base and a cover.

The number of cocoons made, and their dates, were as follows:

(1) ♀ No. 131: June 4, June 7. 2 cocoons.

(2) ♀ No. 133: June 4 (hatched June 23); June 9; June 17; June 20. 4 cocoons.

(3) ♀ No. 135: June 8 (hatched June 22); June 9; June 13; July 5; July 8; July 9; July 11; July 15; July 31. 9 cocoons.

(4) ♀ No. 137: June 10 or 11 (hatched June 24); July 3; August 3; August 19. 4 cocoons.

(5) ♀ No. 141: July 3; July 7; July 13; July 26. 4 cocoons.

(6) ♀ No. 143: July 4; July 24. 2 cocoons.

(7) ♀ No. 145: July 10; July 15; July 24; July 30; August 11. 5 cocoons.

(8) ♀ No. 147: June 4 (hatched June 18); June 6 or 7; June 17 (hatched July 3); June 22; July 4; July 18; July 27. 7 cocoons.

(9) ♀ No. 149: June 14 (hatched June 29); July 16; July 19; July 23; July 29; August 1. 6 cocoons.

The quick succession of these cocoons will be noticed, sometimes cocoons being made upon consecutive days. This is because only a few eggs (perhaps never more than 12 or 15) are laid in any one cocoon. The base of the cocoon is a flat disk, generally broader than the more or less arched cover; the cocoons are pure white. In the test-tubes most of them were placed against the glass, others built upon the web; sometimes they were arranged in rows, one placed upon another.

Care of the Young.—The mother appears not to remain by her cocoons nor to guard them in any way. The young make their own way out of the cocoons, emerging at one point between the base and the cover.

Feeding.—Relatively to its size this species is the most forward in attack, attacking large insects, such as blue-bottle flies, which many larger spiders flee from. It evidently trusts to the great strength of the web, in which large insects become helplessly entangled. The little spider rushes immediately at the entangled victim, seizes hold of it with his jaws without spinning upon it, and keeps his hold though violently shaken by the prey.

Theridium tepidariorum C. Koch. Pl. IV, fig. 2.

Individuals observed, males: No. 7, captured April 29, killed May 19; No. 8, captured April 29, moulted the same day, escaped the same night; No. 13, captured May 1, escaped May 3; No. 19, captured; May 2, killed May 16; No. 20, captured May 2, killed by ♀ No. 17 May 18; No. 71, captured May 8, killed May 23; No. 77, captured May 13, moulted May 15, died (of starvation probably) June 3; No. 81, captured May 14, killed May 18; No. 115, captured May 24, killed next day; No. 116, captured May 24, killed next day; No. 123, captured May 26, died June 7; No. 125, captured May 26, died June 11; No. 126, captured May 26; No. 127, captured May 26, died June 6; No. 155, captured May 30, died June 29; No. 217, captured June 19, died June 29; No. 254, captured June 26, killed (by ♀ No. 253) July 10; No. 319, captured July 14, died August 6.

Individuals observed, females: No. 6, captured April 29, died June 19; No. 16, captured April 29, died about September 1; No. 17, captured April 29, moulted May 9, killed May 30; No. 18, captured May 2, died (apparently starvation) June 2; No. 26, captured May 2, killed May 8; No. 76, captured May 13, died (starvation) June 3; No. 124, captured (on the same web with ♂ No. 123) May 26, died July 3; No. 129, captured May 26, died July 29; No. 154, captured May 30, died about September 1; No. 156, captured May 30, died July 23; No. 202, captured June 11, died July 29; No. 253, captured June 26, died about September 1.

Moulting.—This was observed in one ♂ only; the process lasted about

half an hour, the spider slowly falling out of its old skin, and the legs were quite colorless immediately after the moult.

Mating.—The method of observation was to keep a female in a cage until she had made a web there, then to drop a ♂, handling him as gently as possible, upon her web.

The introductory steps of the mating are as often made by the female as by the male, and she often shows quite an insatiable eagerness, even sometimes leaving food to approach the male. As soon as the male commences to move upon her web she recognizes him as a male of her own species, and, when she is eager, commences immediately to signal to him, both spiders being on the lower surface of the web and upside down (the usual position). The female hangs to the web with the third and fourth pairs of legs, and shakes the longer second and first pairs vigorously and spasmodically in the air (when those legs are not attached to web lines), otherwise with them she shakes web lines to which they are hooked. This "signalling" is a sign of eagerness on the part of the female, and so far as I have observed she makes it at no other time than when she is eager and notices the approach of a male of her own species. There are individual differences in the mode of signalling, as well as differences in accord with the degree of eagerness of the female; sometimes a female signals without moving from her original position, sometimes with the signalling she moves by short steps toward the male. When she is not eager she either remains motionless, or else rushes hostilely toward the male as at an object of prey; in both cases the male makes no advances, and when she is markedly aggressive he escapes by dropping from the web. The whole attitude of the male is that of combined timidity and eagerness; he is much smaller than the female and upon a foreign web, and usually acts with great caution. Very frequently he will climb about the web for a greater or longer period, the female all the while signaling, before he approaches her; often he approaches and touches her several times and each time rapidly withdraws again; more rarely, the male responds quickly to the signalling of the female and copulates within a minute of time. Sometimes the male, while moving about on the web, on coming across a break in it, will pause to mend the break before approaching the female. The male shows his eagerness by a spasmodic jerking of his abdomen. He tests the eagerness of the female, and finds her position on the web, by grasping with the claws of his first pair of feet the web lines that she is shaking by her signalling, and by drawing these web lines taut he feels her movements all the more distinctly; he approaches gradually nearer her, guided by her signalling. and finally makes a short rush toward her.

In this species the courtship, if the expression of eagerness may be so called, comes evidently much more from the female than from the male; and that the male is not able to satisfy the female is shown by the fact that the latter continues her signalling for some time after the copulation. The mode of sexual recognition is entirely by touch, by the tension of the web lines.

The copulation I have observed many times. Both individuals being on the lower surface of the web (in small cages the female spinning a horizontal web about half-way between the floor and the roof), on the close approach of the male the female hangs to the web by the claws of her third and fourth pairs of legs, her other legs hanging unattached, so that her cephalothorax lies beneath her abdomen. The male places himself parallel to her, his ventral surface opposite hers, his cephalothorax also above her abdomen, his position in the web higher so that his head is opposite her epigynum, embracing her closely with his second and third, sometimes also with the fourth pair of legs, while his long first pair of legs beat about in the air. His palpi are applied to her epigynum generally both at the same time; sometimes only one palpus is employed during one copulation. The length of time of the application of the palpi is rarely 15 seconds, usually less than 10 seconds, and all this time the female remains perfectly motionless. The copulation completed, the male hurries away, or else falls down out of the web and remains for some seconds motionless, his energies evidently spent. After copulating he cleans his palpi with his jaws. Sometimes the male has difficulty in inserting his palpi into the epigynal orifices, and tries ineffectively many times while the female remains motionless. The copulation is so soon over that I have not been able to determine the exact action of the palpi during it.

This species copulates very frequently, and there are several matings preceding the making of each cocoon. The female appears always eager except in the time of full pregnancy, and may mate with numerous males, as the following data show:

(1) ♀ No. 6 copulated with ♂ No. 7 at 7.53 P.M., April 29, and this ♂ showing no more desire was removed at 9.25. Put him with her April 30, copulation at 1.43 P.M. Again on April 30, at 11.12 P.M. Again at 7.44 P.M., April 30, half a minute after he was put in. On May 3 I put him with her again for two hours, but no copulation. On May 4, copulation at 9.20 A.M., five minutes after he was put in; and again at 8.39 P.M. and 8.43 P.M. May 5, put him in again at 7.59 P.M., copulation within half a minute, and a second one at 8.01. On May 6, when I put him upon her web, she acted hostilely. May 8.

copulation at 5.24 P.M., half a minute after his introduction. On May 11 she was hostile to him, as also on May 13; at this date she was very large with eggs, which she laid May 19. May 24 I introduced ♂ No. 115 at 4.51 P.M., he copulated immediately; he was removed at 4.05, and ♂ No. 116 placed with her, copulating at 4.07½ and 4.08. May 25 I put in ♂ No. 116 from 10.10 to 11.00 A.M., but he avoided her, though she made amatory signals; and ♂ No. 115 behaved similarly on the evening of the same day. May 27, ♂ No. 125 copulated at 2.50 and 2.53; and the same ♂ at 8.43 and 8.45 P.M., May 28. On May 28 put in ♂ No. 128, copulation at 8.57½ and 8.58 P.M. May 29, put in ♂ No. 125, copulations at 6.00, 6.01, 6.02 P.M.; and he copulated with her on June 1, at 5.30½ and 5.31 P.M. June 2, ♂ No. 126 was placed in her cage, but he showed no eagerness and was removed at 9.25 P.M.; then ♂ No. 125 was put in, and copulation followed at 9.32½. June 30, put in ♂ No. 125, but no copulation ensued, although she was eager. June 17, put in ♂ No. 215 at 11.00 A.M., and two copulations followed within 3 minutes. (A total of 27 observed copulations.)

(2) ♀ No. 16 copulated with ♂ No. 13 at 7.55, 7.56, 7.56½, 7.58, 8.00 and 8.04½ P.M., on April 29, the ♂ after each copulation moving half an inch away from her and drawing his palpi through his jaws. May 4 I introduced ♂ No. 19 from 7.35 to 9.40 P.M., but there was no copulation. On May 5, ♂ No. 19 copulated at 8.14, 8.18 and 8.19 P.M.; and the next day at 7.39 P.M., a minute after his introduction. On May 8 ♂ No. 19 copulated with her at 5.33 and 5.37 P.M.; and on May 13 at 4.22 and 4.23 P.M. On May 14 I introduced ♂ No. 7, on May 15 ♂ No. 19, on May 16 ♂ No. 19, but she was hostile on each occasion (she oviposited May 25). On May 25, at 10.10 A.M., just after the completion of the cocoon, ♂ No. 115 was introduced; she first rushed at him, then held herself in copulating attitude, then became again hostile. May 27 I introduced ♂ No. 127 at 3.10 P.M., she rushed at him and started to enshroud him, but when he touched her with his legs she ceased, and copulation followed at 3.11 and 3.12. May 28, ♂ No. 127 was put in at 9.08 P.M., copulations followed at 9.09, 9.09½, 9.10. May 29, ♂ No. 127 copulated at 5.27 P.M.; but when ♂ No. 128 was put in his place at 5.30, she chased him hostilely. June 1 I put in ♂ No. 127, but she acted hostilely (perhaps from hunger this time, as she had not been fed for three days). June 2 I introduced ♂ No. 127 while she was feeding, and she chased him from the web. June 7, ♂ No. 182 was introduced, but though she signalled eagerly he did not mate. June 15 (a cocoon was built by her the preceding day) I introduced ♂ No. 182, copulation ensued at 7.25 and 7.27 P.M. (A total of 22 observed copulations.)

(3) ♀ No. 18 was put into the cage of ♂ No. 8 on May 2, but she chased him; then ♂ No. 19 was introduced and copulated with her at 11.27, 11.29, 11.29½ and 11.31 A.M. Two Theridiids of a smaller species were put in at 12.00 M., so that five spiders were now together. ♀ No. 18 sometimes would make amatory advances to ♂ No. 8, but he (evidently not mature) fled from her. Several times she came into contact with ♂ No. 19, but after a few excited advances he left her each time. She always acted hostilely to the individuals of the smaller species. She copulated with ♂ No. 19 at 12.42; this ♂ later made a rush at the smaller ♂ No. 8. The latter subsequently escaped, and I removed ♂ No. 19 on May 4. On May 8 a freshly caught large ♂ was introduced, but she seemed frightened by him. On May 9 she copulated with ♂ No. 71 at 7.55 P.M.; he was left in her cage until May 23, and copulations were noticed at 9.15 P.M., May 13, and 9.15 P.M., May 15. (A total of 8 copulations observed.)

(4) ♀ No. 76. ♂ No. 77 was introduced on May 13, but she remained immovable, and was hostile to him next day, as she was to ♂ No. 85 on May 15, and to ♂ No. 77 on May 16. May 18, ♂ No. 77 copulated at 6.59 and 6.59½ P.M. (Only 2 copulations.)

(5) ♀ No. 124 copulated with ♂ No. 123 on May 27, at 2.17, 2.22, 2.27 P.M., besides some unsuccessful attempts. The same ♂ made several unsuccessful attempts on May 28, and one successful one. May 29 I introduced him while she was feeding, she left her prey and signalled vigorously, copulation at 5.49 P.M. May 30, copulations with the same ♂ at 4.44 and 4.49 P.M.; and at 4.55 P.M. ♂ No. 155 was introduced, but he would not answer her amatory signals. On June 1 ♂ No. 123 made protracted but unsuccessful attempts to copulate at 5.43, 5.46, 5.47 and 5.47½ P.M. June 2 she copulated with ♂ No. 128 at 10.28½, 10.29 and 10.32 P.M. June 8 I put in ♂ No. 128 again at 1.36 P.M., while she was eating a beetle; she signalled immediately while remaining close to the beetle, he went toward her and mistakenly tried to copulate with the enshrouded beetle, but ultimately copulated with her at 1.40 and 1.42. June 12 I put in ♂ No. 128 again, copulations followed at 8.59 and 9.16 P.M.; I left them together, and next morning found she had eaten him. (A total of 23 copulations observed, of which a number were unsuccessful.)

(6) ♀ No. 129 copulated with ♂ No. 123 at 8.31 P.M., May 28; later he attempted to insert his palpi but in vain, she then became aggressive. June 2 she copulated with ♂ No. 155 at 8.37 and 8.43 P.M. June 7, with ♂ No. 155, at 8.24 P.M., half a minute after his introduction. June 15, with the same ♂, at 7.23 P.M. (A total of 5 observed copulations.)

(7) ♀ No. 156 copulated with ♂ No. 123 at 12.10, 12.12, 12.12½, 12.13 P.M., June 3. June 19, three times with ♂ No. 217. July 15, at 3.30 P.M., with ♂ No. 319. (A total of 9 observed copulations.)

These observations show that while the copulations are of brief duration, generally less than 10 seconds, they are frequently repeated. The number must be larger in natural conditions than my figures show for caged individuals, since in order to count the number I was obliged to remove the males during those periods when I could not watch them. Even when there are one or more cocoons in her web the female mates as freely as before oviposition, and their presence does not in any way seem to retard her mating impulses.

Sperm-induction.—The following was the only case observed. ♂ No. 319, after copulating with ♀ No. 156 at 3.30 P.M. on July 15, was watched carefully with the hope of seeing this process. He left the female and went to a corner where he remained quiet, hanging with the ventral surface uppermost and the cephalothorax a little lower than the abdomen. At 4.35 P.M. he flexed his abdomen slightly on its pedicel so as to elevate its apex, deposited from his genital aperture a small drop of sperm upon a line of the web, then applied the palpal organs alternately to this drop. This process continued until 4.39 P.M., when he was driven away from the place by the approach of the female. The droplet of sperm had been only slightly diminished in amount, so that probably the induction into the palpal organs takes a much larger time. I watched him for half an hour more; for a while he shook his palpi slightly in the air, but ceased this action and did not emit any more sperm.

Cocooning.—The brown ovoid or subglobular cocoons are very familiar objects in barns and cellars where this species is most frequently found. In captivity they make their cocoons usually in the early morning, completing them before 8.30 A.M., in one case as late as 10.00 A.M.

The process is as follows: ♀ No. 16 was observed commencing her first cocoon at 8.15 A.M., May 25. She was making a fluffy ball of loosely curled white silk, barely a third the diameter of the finished cocoon, suspended by a thread from the roof of the cage. She worked by hanging in the web with her first pair of legs, using the legs of the fourth pair in alternate action to pull out from her spinnerets and apply to the silken mass the white thread, and occasionally helping with the third pair of legs. At 8.23½ she placed her epigynum close to the lower surface of the silken ball, and there issued from her genital aperture a large, yellowish, viscid drop of fluid in which ova could be

indistinctly seen; this drop was not very transparent, so that I could not determine whether the drop was first exuded and then the ova rolled into it, or whether they were discharged together, but appearances were more in favor of the last supposition. This drop was very viscid and of thick consistency, holding a spherical shape and enclosing the ova, and adhering firmly to the silken ball. At 8.27 she completely freed herself from the drop, and then commenced to spin over it. This was accomplished by hanging with the first and second pair of legs from the web, the legs of the fourth pair in alternate use applying the thread to the surface of the drop; while the third pair of legs and the palpi were employed in concerted action so as to revolve the whole mass on its suspending silken thread. The spinnerets at this stage were not applied directly to the cocoon, From 8.27 until 8.55 she was on the left side of the cocoon, revolving it slowly from right to left; from 8.55 to 8.58 on the right side, then turning it in the opposite direction; from 8.58 until 9.00 on the left side of it, revolving it again from right to left. At this time the cocoon was of nearly its final size, almost spherical, its diameter a little greater than the length of her body. The egg mass and the original silken ball were completely covered and hidden by closely matted brownish silk. From 9.00 until 9.17 she crawled slowly over its surface, pressing against it with the tips of her palpi used alternately, evidently to mat down and smooth the whole, the feet being used simply to hold on with. At 9.17 she started applying new anchoring threads to the cocoon, this process continuing until 9.25; this was done by applying the spinnerets directly to the cocoon, then carrying each thread so fastened to an adjacent part of the web; about 15–20 such supporting threads, attached to different parts of the cocoon, were made. She rested until 10.05, then made a few more supporting lines.

♀ No. 202 likewise commenced cocooning by making a ball of curled threads, as did No. 16, her cephalothorax placed above her abdomen during the process. This continued up to 8.28 A.M., when she held her epigynal aperture against the lower surface of the ball and oviposited upon it at that point; the oviposition lasted from 8.28 to 8.31, the ova coming slowly out of the genital aperture one at a time and included in a viscid drop. At 8.32½ she commenced spinning again, covering first the lower surface of the mass of ova, then the sides, the cocoon becoming regular in form by her revolving it. This continued until 9.25 without interruption, when she stopped spinning, and instead slowly revolved the cocoon (now brown in color) and kneaded its surface with her palpi; this continued until 9.45, when she bit loose

certain web lines around the cocoon, and fastened new supporting lines to it.

♀ No. 154, after making 3 normal cocoons, all suspended in her web, made a mistake in the construction of her fourth one. On July 24, at 8.13 A.M., I found her finishing the base (fluffy ball) of the fourth cocoon; but owing to some accident this was not a rounded mass of silk, but a hollow cone hung from its apex by a thick thread; the form had probably become changed by her weight upon it. From 8.20 until 8.23 she clung to this base, pressing her epigynum several times against its lower opening, and from 8.23 to 8.24 she oviposited upon it. But her weight upon the silken base had gradually unraveled the latter, so that it becoming pulled out, the egg mass sank with it to the floor, where all adhered to some dead flies. From 8.24 until 8.40 she made several ineffectual attempts to raise it into the web, then she left it and went to cocoon No. 3, spun a cap of silk first around its lower surface, then upon its sides, then kneaded this new covering with her palpal tips. Evidently she had the impression that she was finishing the cocoon already begun, and seemed to have forgotten the neglected egg mass. At 10.05 she returned to the latter and fed on the eggs, probably confusing them with the dead flies to which they adhered; at 10.10 she pulled excitedly at the neglected base, as if trying to raise it, for 6 minutes, but then left it on the floor and did not return to it again. Thus she had not been able to rectify the misshapen base of the cocoon, and under the impulse to make a covering had made this covering around an already finished cocoon.

In all these cocoonings, then, a base of a spherical mass of loosely curled silk is first formed, the ova (included within a viscid drop of fluid) deposited upon its lower side, then the whole covered with silk, finally this covering kneaded with the ends of the palpi. The reason why the external surface of the cocoon is brown in color I cannot say; possibly the silk secreted last may be different chemically—*i.e.*, proceed from different spinning tubes. In one case a complete cocoon was made without oviposition.

A succession of cocoons are formed by the same individual, the number of those made by my captives with the dates of their construction being as follows:

(1) ♀ No. 6: May 19 (the ova did not develop).

(2) ♀ No. 16: May 25 (hatched June 28); June 14 (hatched); July 7 (eggs did not develop); July 14 (eggs did not develop); July 24 (hatched); July 31 (only a few of the eggs hatched); August 21 (hatched). 7 cocoons in all.

(3) ♀ No. 129: June 2 (hatched June 14); June 24. 2 cocoons.

(4) ♀ No. 154: June 3 (hatched June 15); June 8; June 24 (hatched); July 24 (this was the incompleted cocoon described above, the eggs shriveled up); August 6 (eggs did not develop); August 15 (only a few of the ova hatched); September 1 (hatched). A total of 7 cocoons.

(5) ♀ No. 156: June 28 (this cocoon contained no ova).

(6) ♀ No. 202: June 14 (hatched June 28); June 24 (hatched July 8); July 3 (hatched July 14); July 12. A total of 4 cocoons.

(7) ♀ No. 204: July 14, the ova after a few days were shaken out of this cocoon into a test-tube to see if they would develop, and they all hatched on June 26.

(8) ♀ No. 253: July 24 (hatched August 4); July 30; August 6; August 16; August 27. A total of 5 cocoons.

Probably the rapidity in the succession of the cocoons is directly dependent upon the richness of the food supply. The time of hatching would be dependent, among other factors such as temperature, upon the thickness of the cocoon covering through which the young have to escape.

Care of the Young.—There seems to be solicitude for neither the cocoons nor the young, though the mother will not eat the latter. The mother does not guard the cocoons, and she stays near them simply because they are generally placed in that highest portion of the web where she is accustomed to dwell. Sometimes on the introduction of a fly, the mother will enshroud it alongside of a cocoon, and after sucking it dry, will cut it, with the cocoon, loose from the web; such fallen cocoons are not lifted again into the web. The young, on hatching, move in the direction of the strongest light, whereas mature individuals avoid the light; this instinct would serve to scatter them from the maternal home.

Feeding.—Living prey is recognized entirely by its pulling upon the web lines; and this species is one of the boldest of our local spiders, attacking without hesitation insects and spiders much larger than itself. That is, the females do, but the males are much more timid. A rush is made toward the struggling insect, a line of silk attached to it, and then the spider, hanging by her first pair of legs, applies the issuing silk thread to the victim's surface by the very rapid application of the three last pairs of legs. Not until the victim is closely enshrouded does the spider bite it, and she enshrouds just up to that point when the victim is rendered motionless by the envelope of silk. Often the enshrouded prey is carried to another part of the web to be eaten; and after being sucked dry is bitten loose from the web and allowed to fall out of it.

Teutana triangulosa Walck.

This is locally quite a common species in houses, but much less abundant than *Theridium tepidariorum.*

The following individuals were kept in captivity: ♂ No. 173, captured June 4, killed by ♀ No. 70, June 19; ♀ No. 70, captured May 8, killed by accident August 15; ♀ No. 153, captured May 28, died July 22; ♀ No. 176, captured June 5, still living.

Mating.—Four different males of *Theridium tepidariorum* were placed upon the web of ♀ No. 70, but she was hostile to each. On three different occasions ♂ No. 173, of her own species, was placed upon her web; she signalled to him by pulling upon the web lines, shaking her first pair of legs, but he avoided and was finally eaten by her. Her mode of signalling was like that of *Theridium tepidariorum.*

Cocooning.—This process I saw only once. ♀ No. 153 was seen at 9.05 A.M., June 15, to have spun a small ball composed of looped threads suspended in the web; she continued to add to it until 9.10, holding to the lower surface of the ball ("base" of the cocoon) with her ventral surface turned toward it, raising her spinnerets to apply them to the ball, dropping them, then raising them again for another application, the length of the "stroke" accounting for the looseness of the threads. At 9.10 she placed her genital aperture close to the lower surface of the silken ball, and deposited there a globular, viscid mass enveloping ova; this oviposition lasted just half a minute. Then she immediately began spinning over the egg mass, laying down long threads upon it, making the covering spherical by revolving her body around the cocoon, whereby she first supported herself by the surrounding web lines, later by hanging to the cocoon itself. She stopped spinning at 9.21. The cocoons of this species are snowy white, spherical, and peculiar in that they are so loosely constructed that the yellowish egg mass may be seen through them.

In natural position the cocoons are hung high in the web, generally attached to some object (such as a board) that roofs over the web; in captivity some of the cocoons were attached to the roof of the cage in conformity with this habit, but as often they are placed lower in the web. In natural conditions, also, the cocoons are generally placed close together, in that part of the web where the spider spends most of her time.

The number of cocoons made by my captives, and the dates, were as follows:

(1) ♀ No. 70: May 21, June 3, 15, July 18, 26, August 2, 13. A total of 7 cocoons.

(2) ♀ No. 153: June 2 (hatched June 27), June 8 (hatched August 14), June 15 (hatched July 17). A total of 3 cocoons.

(3) ♀ No. 176: June 15, 26 (hatched July 16), July 10 (hatched July 30), 16, 27, 31, August 5, 15, 21, 28. A total of 10 cocoons.

Care of Young, Feeding Habits.—I found no indications of maternal guarding of the cocoons or young, but the mother appears indifferent to both. It is the habit of this species, after sucking a victim dry, to cut it loose from the web, and at such times a cocoon is sometimes cut loose also, and then not raised again into the web. This species is very courageous and rushes at large flies, quickly enshrouding them with silk, which is applied with the fourth pair of legs; sometimes the struggling victim chances to be in contact with a cocoon, and then the spider frequently enshrouds both together. The young cut their own way out of the cocoons.

Steatoda marmorata (Hentz).

One male and five females were kept in cages.

Mating.—♂ No. 46 was placed upon the web of a female, both remained motionless for a while, then she killed him. Another female killed an introduced male of *S. borealis* (Hentz).

Cocooning.—This was seen only once, and only the end of the process observed. At 7.30 A.M., May 28, I found that a female had oviposited upon a mass of silk, and was then engaged in spinning over it. The spider held to the cocoon with her feet, and spun upon it (not using the legs to apply the thread) by attaching the spinnerets at one point, elevating them, and applying them again close to the first point of attachment, thus forming looped threads; in one minute I counted 22 such applications of the spinnerets. The spider in spinning slowly rotates around the cocoon. The cocoon is suspended in the web, white in color, spherical and rather loosely made. In no case were more than 2 cocoons made.

Feeding Habits.—This species is relatively very powerful and courageous, and quickly overcomes its victims by discharging upon them a thread that is remarkably viscid and tenacious; minute viscid drops can be seen upon this thread with the naked eye. This is a process of enshrouding that consists, not in wrapping the victim in threads, but rather in pouring out the very sticky secretion upon it. The spider stands upon her first two pairs of legs with her posterior end toward the object of prey, and applies the viscid thread to the latter with her other legs.

Linyphia clathrata Westr.

Moult.—At 6.40 P.M., May 7, I dropped a male of this species on to the floor of a cage, and after a few minutes he fell upon his left side and commenced to moult. His palpi and all four pairs of legs were held straight at right angles to his ventral surface. The whole process lasted somewhat less than five minutes. The old skin split by a horizontal break, just below the eyes anteriorly, and on the sides just above the legs and along the sides of the abdomen; thus it opened in two pieces, a dorsal and ventral, which remained connected together by a narrow strip close to the spinnerets. His repeated jerking flexions of the cephalothorax gradually freed first his cephalothorax, then his legs and abdomen. After the moult he rose to his legs, but was unable to walk until the expiration of 16 minutes.

Pholcus phalangioides Fuessl. Pl. IV, fig. 3.

Individuals observed, males: No. 87, captured May 16 on the web of ♀ No. 86, killed by ♀ No. 82, May 27; No. 88, captured May 17, killed by female No. 12 the same day; No. 175, captured June 5, died June 7; No. 180, captured June 7, escaped June 16; No. 245, captured June 23, died June 26.

Individuals observed, females: No. 9, captured April 29, still living; No. 12, captured April 29, died August 15; No. 15, captured May 1, moulted May 24, still living; No. 82, captured May 15, moulted May 22, still living; No. 86, captured May 16 (on the same web with ♂ No. 87), killed May 31, and immature at death; No. 174 captured June 5 (with a cocoon), died July 5; No. 179, captured June 7, died June 25 (from starvation); No. 181, captured June 7, died August 7.

Mating.—The following data include the more important observations:

(1) ♀ No. 9. On June 5, at 12.49 P.M., after she had been well fed, ♂ No. 175 was placed on her web. He first remained quiet, then touched her with his legs; at 12.56 she reached toward him and he fell from the web. At 1.06 he climbed into the web, and she moved toward him. At 1.25 he hung below her and touched her fore-legs with his, when she drew her legs away, he continuing to stretch out his first pair of legs toward her. She had in the meanwhile drawn up to herself a former enshrouded victim, and this intervened between them when, at 1.43, he tried to embrace her, so that he removed it and touched her head with his chelicera. She hung perfectly motionless in her usual position, her abdomen above her cephalothorax and directed vertically upward. The position of his body was the same, but his legs were outside of hers. At 1.47 he inserted both palpi at once, and hung to her by them, his weight pulling her abdomen into the horizontal plane. The position of the two in copula was then as

follows: The female with her abdomen horizontal and ventral surface down, her cephalothorax flexed at an angle downward; the ♂ below her, his cephalothorax about vertical and his head almost touching the ventral surface of her abdomen at the anterior end of the latter, his abdomen flexed at more than a right angle with his cephalothorax; the long axis of his abdomen thus made a wide angle with the long axis of hers, like a V. Thus they continued motionless until 2.19, when he dropped to the floor, and when he attempted to climb into the web again she chased him so vigorously that I removed him. On June 7, at 7.55 P.M., ♂ No. 180 was put in; they embraced in copulatory attitude for a minute, but she moved her legs, and he left her and went to another part of the web. At 8.17 she tried to enshroud him, so I separated them. On June 14 I put in ♂ No. 180 again, at 4.36 P.M.; he remained quiet for six minutes, then climbed up and touched her, whereupon she made her shaking motion. He then hung beneath her, shaking the web very gently by a swaying of the whole body, she responding in a similar way. At 4.47 she rushed at him, and I removed him.

(2) ♀ No. 12 killed and ate mature ♂ No. 88 on May 17, and an immature ♂ on May 24, and made her first cocoon on May 27. On June 23, ♂ No. 245 was introduced at 12.12 P.M. (the cocoon had hatched on June 15). At 12.21 he started to move with long pauses, while she was above him in the web and testing his movements by drawing the web lines taut. At 12.28 he inserted his palpi in her epigynum for a second, then fell to a lower position upon the web. At 12.30 he made several attempts to insert both palpi, and succeeded half a minute later. The position of the two was as in the preceding case, she hanging in the web by her posterior three pairs of legs, he hanging to her by his inserted palpi, his anterior three pairs of legs loosely embracing hers (and their claws hooked to web lines), his fourth pair of legs directed behind him and also hooked to web lines. The palpi were inserted by pressing them in this flexed position along the ventral surface of her cephalothorax backward to her epigynum. When inserted, a large vesicle or sac was evaginated from the lateral side of each palpal organ. I watched the copulation from 12.30 to 12.55, when I was obliged to leave, and on my return at 1.25 found them separated, he feeding on a beetle which she had previously enshrouded.

(3) ♀ No. 82. I put ♂ No. 87 with her from May 17 to May 22, when he was repeatedly observed to make advances toward and to touch her, but she acted slightly hostile to him and no copulation was

seen. She moulted on May 22. On that day (he had remained all this time in her cage) I watched a curious kind of courtship between them from 8.00 to 9.40 P.M. They hung opposite each other in the web, he by his first pair of legs, she by her first and second, reaching out and parrying with their other legs. His head pointed directly downward, her body in a horizontal position with the dorsal side down. During this process, which continued with few interruptions during the period of observation, he changed his position only slightly, while she moved about somewhat. Sometimes he made a short advance toward her, then not holding his palpi directed anteriorly (as usual) but with their stalks bent ventrad, so that the large palpal organs were bent upon his cephalothorax; at each such attempt at copulation the striking of her legs against him seemed to frighten him, and he withdrew. Both became quiet at 10.00. If this was a courtship, she appeared more active in it than he. On May 23, 24 and 25 I watched the pair at intervals, but saw no copulation. But at 10.20 P.M. on May 26 I found them in copula; they certainly had not been more than 15 minutes in that act. This copulation lasted without interruption to 11.31. Then he climbed to the bottom of the cage, when she actively chased him, and finally contented herself with feeding upon a former enshrouded victim. The attitudes of the two were as in the preceding cases. Both palpi were continuously inserted at once, and neither withdrawn, though each at intervals underwent a slight lateral movement; they were so firmly fixed in her epigynal apertures as to bear the greater part of his weight; at each side of each palpal organ was clearly visible an evaginated, rounded sac, which collapsed after the withdrawal of the palpi. This male had lost his third pair of legs; with his fourth pair directed caudad he hung to the web; the left foot of his second pair was hooked to the tarsus of the left leg of her second pair; the right foot of his second pair was hooked to the tarsus of the right foot of her fourth pair; the left tarsus of his first pair rested against the left tarsus of her fourth pair; and the right tarsus of his first pair rested upon the tarsi of her first and second pairs. Next day she killed this male.

(4) While her young were scattered upon her web, I put in ♂ No. 245 to ♀ No. 174. At the end of five minutes she rushed at and tried to enshroud him, when I separated them.

From these observations it is apparent that there is no real courtship on the part of the male; he approaches her with great caution, tentatively touching her with his legs, and only then attempting copulation when she remains immovable under his touches. In all the cases

the female attempted to kill the male after copulation, and very frequently before; then he escapes by falling from the web, and always approaches her from beneath. The time of copulation varied from 11 to 32 minutes.

Cocooning.—The making of the cocoon I have not seen, though I have watched pregnant females for long intervals in the hope of seeing it. Pokrowsky (1899) is the only writer who has described this process. The cocoon is a very thin, white, silken covering to the globular mass of eggs; so thin and flimsy that we can be sure that there is a real silken cocoon only by the white case that is left after the young have escaped from it. The number of cocoons furnished by my captives was as follows, each date given representing the time of making of a particular cocoon: ♀ No. 9, June 24 (hatched July 12), July 26, August 30 (hatched September 23); ♀ No. 12, May 27 (hatched June 15), July 19 (this cocoon was dropped to the floor and did not hatch); ♀ No. 82, June 14 (hatched July 4), July 19 (this cocoon was dropped and did not hatch), August 16 (hatched about September 1), latter half of November, (hatched in December); ♀ No. 179, June 16 (this was dropped and did not hatch); ♀ No. 181; June 23 (this was dropped and did not hatch), July 19 (hatched August 4). Thus none produced more than 3 cocoons, and when a cocoon was dropped it did not hatch.

Care for the Young.—As numerous writers have noticed, the mother carries her cocoon suspended in her jaws. But it has always been stated that the cocoon is carried until the young hatch. While I have found this to be the case in one or two instances, I have seen more cases where the mother will occasionallv suspend her cocoon temporarily by a line to the web, in order to clean herself and to feed. This is the more remarkable since rough handling does not cause the mother to loose her firm hold upon the cocoon, and her jaws are so firmly imbedded in its lining that, even when she wishes to, she has difficulty in breaking her hold upon it. Perhaps some of these cases where the cocoon falls to the ground are mishaps occasioned by the mother losing her hold upon her cocoon when trying to suspend it upon a thread. That such a suspension is frequent is shown by the following facts: ♀ No. 9 held her cocoon continuously in her jaws from June 24 up to July 2; on the latter date I gave her a fly, she chased and quickly enshrouded it, then left it and went to the roof of the cage, where she spun a few fine lines, then with the help of her second and third pairs of legs removed the cocoon from her jaws, held it with these legs while she touched her spinnerets to its surface three times, then left it hanging on the fine lines thus made, and which were at-

tached to the roof by her third pair of legs, and went back and fed upon the fly; after this meal she returned and took the cocoon into her jaws again. She repeated this process next day with another fly, and the day following without a fly being put in. ♀ No. 12 was observed to do the same operation once with her first cocoon to secure food, and once with her second in order to clean herself. ♀ No. 82 was observed to do so also. ♀ No. 181 was observed to do so likewise in order to clean herself, and she, when regaining the suspended cocoon, first seized its envelope with her jaws, then with her legs snapped the supporting lines.

The hatching of the young has been observed before, but never very fully described, so that a few notes may be of interest. ♀ No. 82 was observed on the afternoon of July 4 holding her cocoon in her mouth, the young slowly unfolding themselves, the most superficial first; at 2.40 all the young had unfolded and hung as a great mass to her jaws; at 6.15 all had dispersed and the empty cocoon was hanging in the web. With ♀ No. 174 the process was noted in more detail. At 8.30 P.M. the young were beginning to unfold their legs at the lower side of the cocoon, which the mother still held in her jaws; the more superficial of the spiderlings stretched themselves, and by the enlacement of their legs together, and enlacement with the legs of those that succeeded them, there was attached to the mother's jaws a great mass of young spiderlings, a mass of a diameter fully equalling the length of the mother's body. Next morning early I found all the young, nearly 60 in number, distributed over the web, the mother motionless near them, and lower in the web the empty cocoon. ♀ No. 12 acted differently. On June 15, at 2.30 P.M., I found the young spiders beginning to escape from the cocoon, which in this case was suspended from the web, and not from the mother's jaws. At 2.35 she tore away with her jaws a portion of the cocoon, which allowed the young to emerge more easily; this she repeated at 2.40 and 2.43, each time avoiding biting the young spiders. By this time about 17 of the young were upon the web, and the mother moved about the young, spinning, and careful not to injure them. At 3.40 I put a large beetle (*Chauliognathus* sp.) upon her web, which became entangled there and shook the web. For a minute the mother remained quiet, then went to the mass of young which had not yet become scattered, and enshrouded it with silk as she does a victim, but more slowly; then carried it with her jaws. I watched her until 6 o'clock; at intervals she left the enshrouded mass of young hanging on the web, but always returned to it again to take it in her

jaws, and sometimes tore at the silken shroud with her jaws. At 6.15 she started energetically tearing open the shroud, but all the young did not emerge from this silken envelope until a couple of days had passed. It is difficult to explain this act: did she enshroud the young to protect them from the beetle? Or did she enshroud them mistaking them temporarily for the beetle?

Feeding.—It fills one with admiration to watch this feeble spider, with her weak jaws and long hair-like legs, overcoming prey much larger and stronger than herself. It is done by enshrouding the victim with great rapidity. In the operation the spider rushes at the victim, then with cephalothorax up and abdomen down applies with her fourth pair of legs, these legs used in very rapid alternate action and sometimes aided by the third pair, a thread issuing from her spinnerets to the victim, and so within a short time renders it immovable. In case web lines interrupt the free action of her legs, she stops her work to bite these lines loose. The act of enshrouding lasts until the victim is nearly hidden by the thread around it, and completely powerless to move, when the spider carries it hooked to her fourth legs up to a higher place in the web and feeds upon it there. The prey is sucked dry, then cut loose from the web. The agility and strength evinced by this spider is marvelous.

The Shaking Habit.—This is the well-known habit this species has of shaking the body so rapidly by a rotary movement, while in the web, as to render itself almost invisible. Certain Epeirids have the same habit. With *Pholcus* it is an expression of fear, and is resorted to after the web has been severely jarred. Once a female was seen to shake this way after a male was put upon her web; but I never saw such a case repeated, and believe that the female was shocked by some action on my part. It is never resorted to in order to secure prey.

Acrosoma gracile Walck. Pl. IV, fig. 5.

This Epeirid, common in many of the local woods, is remarkable for great sexual dimorphism. The abdomen of the female is hard and corneous, angular and prolonged into spines. The male is much smaller than the female and much more rarely found; his small abdomen is elongated and without spines. On account of these differences it seemed desirable to observe the mating process.

♀ No. 322 was captured July 23, and died August 11; she made in her cage only the foundation lines of a web, but no orb, and so was unable to catch the insects given her. ♂ No. 321 was caught on July 23, and died July 28; he also constructed no orb.

Mating.—On July 27, at 9.27 A.M., the male was dropped upon her web. At 9.31 he touched her, and copulated from 9.32½ to 9.42. She hung ventral surface up by her fourth pair of legs to the web lines, her other legs flexed close to the cephalothorax, her thorax horizontal. The male approached her from in front of her head with his long axis also in the horizontal plane, walking upon the upturned ventral surface of her cephalothorax and abdomen, when he firmly implanted his outstretched left palpus in her epigynal orifice; then keeping the palpal organ there, he swung his body round so as to bring it on the right side of her abdomen, so that now his head was upmost and a little posterior to her epigynum, and the long axis of his body was approximately parallel to an imaginary line joining her spinnerets with the most posterior spinous processes of her abdomen. Here he held on firmly with his feet to the roughened surface of her abdomen, practically out of reach of any of her legs, and was not dislodged even though part of the time she climbed about as if trying to get rid of him. A swollen evaginated sac connected with the inserted palpal organ was clearly seen in dilation, and he held his palpus inserted until it had collapsed. He then disengaged himself from her, but returned and copulated again, from 9.55 to 10.03, this time placing himself on the left side of her abdomen and using his right palpus. Then he left her again and remained quiet most of the time up to 10.30. At 10.32 he approached and touched her, she followed him and once embraced him lightly with her legs, but he avoided her. After that she climbed about, and whenever she touched one of the web lines which he was holding, by a sudden contraction of his legs he pulled the line taut; this was possibly an amatory signal. I watched the pair continuously up to 1 o'clock, but saw no further copulation nor any preparation for sperm-induction.

Epeira labyrinthea Hentz.

Of this abundant and beautiful Epeirid only two individuals were watched. ♂ No. 281 was captured July 2, moulted July 5, died about September 1 (from hunger). ♀ No. 280 was captured July 2, moulted July 13 and 18, and died (from hunger) about October 1. This species, as well known, fabricates a labyrinth of lines behind a vertical orb; the female made such a complete web, but the male made no orb.

Mating.—After the female had constructed her web and had made 1 cocoon, the male was dropped upon her labyrinth on July 26, at 8.07 P.M. She was in her usual position, just beneath her cocoon,

placed high in the labyrinth. He remained immovable until 8.39, when he began to climb about, alternately advancing toward and retreating from her, spinning threads all the while, she remaining suspended head down near her cocoon, occasionally jerking the web lines with her anterior legs (evidently signalling). The male finally made two or three quick motions toward her, withdrew each time, then copulated with her at 8.44 and again at 8.44½. Each copulation lasted barely 5 seconds; she hung head down with legs loosely flexed, like the female of *Theridium tepidariorum*, her ventral surface turned toward him; he embraced her legs with his, head downward also, but the copulation was so rapid that I could not determine how he applied his palpi, except that both seemed to be applied simultaneously to her epigynum. He then left her and went to a corner of the cage, where he vigorously cleaned his palpi and legs up to 8.58; while she remained quiet in the same place. There was no sperm-induction up to 10.00 P.M., when I left them together; he remained upon the labyrinth of her web up to the time of his death, and the pair seemed perfectly amicable.

There is no courtship, the male finds the female by pulling upon the lines of the web, and her answering pulls are evidently a signal to him of desire upon her part. In natural conditions several males are often found at once upon the labyrinth of the female.

Cocooning.—This female constructed five cocoons, on July 26, July 31, August 9, August 19, and August 27 respectively. In accord with the well-known habit of the species the cocoons were placed in a chain one below the other, the latest formed cocoon being the lowest; the cocoons are brown in color, biconvex, rather conical above and more rounded below and irregularly circular in greatest outline. Though the process of cocooning was not seen, it is very probable that the cocoon is formed of a base and a cover, and that the base is placed highest, and for these reasons: First, there is a well-marked line around the equator, showing a union of two parts. Second, the female, before cocooning, constructs a little tent, in the form of a shallow inverted cone, placed high in the labyrinth, and rests beneath it; this cone is an admirable protection against rain and sunlight, and serves to partially conceal the spider. The males appear not to make such nests. Now when a cocoon is made the female uses this conical nest as the base, thickening it by silk, the eggs are laid in its hollow, then a more nearly flat cover of less diameter is spun to close the mouth of the cone. Then she constructs beneath this cocoon a second nest-cone in which she rests, later incorporates it into a second

cocoon; and so all the cocoons are made (frequently up to the number of 6). Here the nest accordingly is later made a part of a cocoon; probably other Epeirids that make similar silken nests will be found to cocoon in much the same fashion, though I know of one exception (*Epeira benjamina* Walck.). Sitting at twilight during a heavy downpour of rain beneath some trees for protection, I saw a female of this species constructing the base of her cocoon on the under surface of a leaf, at a considerable distance from her nest (the nest is a leaf curled up and lined with silk).

Feeding.—The female rests below her conical nest supported high in the labyrinth behind the orb, and holds taut with her feet a line joined to the orb. When a fly becomes stuck to the viscid spirals of the orb, she quickly runs along the drop-line to the orb, kills it by biting (without enshrouding it), carries it back to her nest to suck it dry, then usually leaves the carcass hanging in the labyrinth. The males that are upon the web of a female during the mating season also feed upon insects caught in her orb, carrying the victims to outlying parts of the labyrinth.

Xysticus stomachosus Keys. Pl. V, fig. 7.

Individuals observed, males: No. 5, captured April 27, moulted May 15, died June 7 on account of injuries incurred in an attempt to escape; No. 108, captured May 19, escaped May 27.

Individuals observed, females: No. 4, captured April 27, moulted May 10, died August 21; No. 109, captured May 19, moulted May 24, still living.

Moult.—♀ No. 4 was found in nearly completed moult at 7.40 P.M., the exuvia adhering then only to the spinnerets. She was lying upon the floor on her left side, with her legs stretched out straight, and later fell over upon her back. She did not rise until 8.03, and 5 minutes later climbed up the wall. This moult has not resulted in any regeneration of a leg broken off six days before. The old skin was in a dorsal and a ventral piece separated by a symmetrical horizontal break, as in other spiders.

♂ No. 5 was found at 8.20 P.M., hanging head downward from the exuvia, which was fastened to the wall; he did not move until 8.38, and did not break away entirely from the exuvia until 8.43.

Mating.—This was studied by keeping a male and a female in the two compartments of a partition cage, removing the partition to see the mating; the spiders showed that they saw each other through the glass partition.

♂ No. 5 was placed with ♀ No. 4 on a number of occasions prior to May 10, the date of her final moult, and on May 13, but he avoided

her each time. On May 15 he completed his final moult, but on the next day he avoided her again; this would show that sexual ardor may not show itself in the male immediately after the final moult On May 17 they were put together at 8.00 P.M. Both remained perfectly quiet within an inch up to 8.57, when she moved toward him with her first two pairs of legs outstretched; he quickly reached out his corresponding legs, seized the feet of her right fore-legs with his right fore-legs, and holding them thus (only the metatarsi in contact) he quickly revolved around her and climbed upon her back from behind. She immediately became immobile with her legs flexed close to her body. He turned about upon her back, holding her with his legs, and feeling her with his palpi. At 9.02 he reached his head downward over the posterior end of her abdomen, placed the ventral surface of his cephalothorax against the ventral surface of her abdomen so that his head was posterior to her epigynum, his abdomen accordingly extending behind hers and tilted upward; his third and fourth pairs of legs held tightly to her abdomen, while his first and second pairs were directed forward to embrace her legs. One palpus at a time he then extended straight forward and applied to her epigynum. The number of palpal applications was, using the abbreviations *r* and *l* for right and left respectively, the first numbers expressing the time extent, the second the number of insertions: r, 9.08–9.12, 8; l, 9.12–9.13½, 6; r, 9.13½–9.36½, 9, the last time inserted continuously from 9.21 to 9.36½. The black spine connected with the palpal organ was pressed into her epigynal aperture, and when so inserted an evaginated sac connected with the concave surface of the organ expanded and collapsed after the withdrawal of the palpus from the epigynum; before another insertion the palpal organ was drawn through the chelicera. At 9.38 he moved half an inch away, and she rose suddenly at 9.41.

The same ♀, No. 4, copulated several times with this male, No. 5 On each occasion their attitudes were the same. The following notes give concisely the duration of time and the number of applications of the palpi, as well the mode of approach of the male.

(1) May 18, as soon as he touched her he immediately mounted upon her back, at 12.09 P.M.; palpi applied as follows: r, 12.16½–12.21, 9; r, 12.21–12.31½, inserted continuously. Then he walked half an inch away, returned and copulated again; r, 12.37–12.41, 2 or 3; he then left and again tried to return, but she repulsed him.

(2) May 19, by touching him I brought him in contact with her he mounted her, and made the following palpal applications: l, 8.28–

8.30, 4, not effectively inserted; l, 8.31–8.33, 1; l, 8.34–8.34½, 1; l, 8.35½–8.36; l, 8.36½–8.42; l, 8.42½–8.43; l, 8.43¼–8.44; l, 8.44–8.46 1; l, 8.46½–8.47; l, 8.47½–8.50; l, 8.50–8.51; l, 8.53–8.53½; l, 8.54½–8.57½. Then she rose and shook him off.

(3) May 21, at 10.17 P.M., he touched her, kept quiet for half a minute, then climbed upon her. He left her for a few seconds at 10.25 then returned and applied his palpi as follows: l, 10.29½–10.35, 5; r, 10.35½ to 10.36, 6; l, 10.38½ to 10.41; r, 10.44½–10.46, several times; l, 10.46 to 10.48, several times; l, 10.48–10.48½, 1; r, 10.48½–10.49½, 1; r, 10.49½–10.51; r, 10.51–10.52½, 4; l, 10.53–10.55, 4; l, 10.55–10.58, 1; r, 10.58–11.08, continuously; l, 11.08–11.12, 1; r, 11.12½–11.17. He then got upon her back, remained quiet there for a while, then I separated them.

(4) May 23, he mounted her at 3.34 P.M. Then the two being in an unfavorable place for study, I pushed them to another place with a pen-handle; she gripped it, and I was obliged to shake roughly to make her leave go, but he did not loosen his hold upon her, and as soon as she had lost her grasp upon the pen-handle she immediately became motionless again with flexed legs. He applied his palpi as follows: r, 3.39–3.40, 6; l, 3.42–3.45, 1; r, 3.45½–3.46, 1; l, 3.46–3.46⅓, 1; l, 3.47–3.50, 1; l, 3.51–3.52, 1; r, 3.52¼–3.54; l, 3.54–4.00; then he walked off for a minute but returned; r, 4.03–4.04½, 1; l, 4.04½–4.07; r, 4.08–4.11; l, 4.12–4.13. He then left her, returned, did so again, but at 4.14 she arose.

(5) May 28, he was placed with her from 9.24–9.50 P.M., but there was no copulation.

(6) May 29, the male mounted her at 8.45 P.M. Palpal applications: l, 9.53–9.56⅓, 6; r, 9.56⅓–9.58½, 2. Then she began to walk about and carried him out of the open cage, and in putting them back I separated them.

(7) June 3, 8.31 P.M. She moved so as to touch him, and a minute later he mounted her. Palpal applications: l, 8.37½–8.39, several times; r, 8.39–8.40½, several times; l, 8.40½–8.45, continuously; l, 8.45½–8.57, continuously; r, 8.57½–9.01, several times; r, 9.01–9.03. At 9.05 he got upon her dorsal side again, a minute later she rose and walked off with him clinging to her. She dislodged him at 9.09, but a minute later he mounted her again, used his right palpus from 9.12 –9.13, then she rose and escaped from him.

♀ No. 109 copulated with ♂ No. 108 on May 24, and on May 25; the attitudes were as in the previous cases. On May 29 she was rather hostile to him, and whenever he tried to grasp her she ran off. Once

with his first two pairs of legs he parried with hers for more than a minute, evidently trying to grasp them; then he sidled off, and when he returned she grasped him with her legs, and finally she gripped fiercely at him.

The descriptions here given may seem unnecessarily full, but they are given to show the variations in the mode of copulation, a greater variation than I have observed in any other species. In one copulation only one of the palpi was used; in the others both palpi, but in irregular alternation. The earlier palpal applications in each copulation are mainly ineffective, the palpal organ not being thoroughly inserted, and a considerable part of the time is occupied in working the palpal organ through the chelicera. Peculiar for this species is the fact of the male sometimes interrupting the copulation by leaving the female for a minute, then returning and resuming it. The longest period of copulation was 48 minutes.

There is no courtship on the part of the male, nor any instigation by the female. When the male is first put into the cage of a female, even though he faces her, he does not seem to recognize her as such by sight, and pays no attention to her until he touches her, when he quickly gets upon her back. My custom was to push him up to the female. He is considerably the smaller and the more active; and when upon her back he is secure from her legs, and is not easily dislodged by her. He mounts upon her from behind, out of reach of her long and dangerous fore-legs, and when he is mounted she immediately becomes still. His smaller size and greater activity enable him to accomplish his purpose, quickness overcoming strength. Seeing the male upon the female, one involuntarily thinks of the Old Man of the Sea, who cannot be dislodged.

Cocooning.—For some two weeks before making her cocoon ♀ No. 4 spun a network of web-lines across her cage, so dense that she frequently became entangled in them, and I was obliged to clean them away. But this is probably not to be considered a web-making, but simply the habit this species has of drawing out a thread behind when walking, a "drop-line" by which it can find its way back. On July 5, however, she made quite a dense sheet of silk in a corner of the cage, completely enclosing her and inclined at an angle from the floor to the walls. Within this she made, in the early morning of July 9, her only cocoon; this cocoon was inclined at an angle to the floor, fastened to the scaffolding, flattened, unevenly circular in outline, and white in color. It did not hatch.

♀ No. 109 built on July 5, at the angle of two walls of her cage with

the floor, a similar sheet-like tent; and on July 9 made her cocoon within it. This cocoon was roughly quadrangular in outline and flattened. It did not hatch.

Care of the Young.—The cocoon is guarded by the mother, who lies upon it and embraces it tightly with her legs. ♀ No. 4 would not leave her cocoon to secure living food during the first ten days, but clung tenaciously to it; but after that she would leave it to chase prey, and afterward would return to the cocoon, or at least to the silk sheet placed before it. By climbing many times upon this silk sheet she gradually demolished it. ♀ No. 109 at first held her cocoon zealously, then neglected it for several days, and finally at this time, October 4, is embracing it again.

Philodromus aureolus Walck.

Cocooning.—A female of this species made 6 cocoons, on she following dates respectively: July 3, 30, August 9, 21, 27, September 6. All these were normal cocoons except one, which I disturbed in the process of making, but the eggs of none of them hatched. The first three cocoons were placed side by side at the angle of the wall and the roof of the cage, the others at the angle of the wall and the floor. The mother constantly stands with outstretched legs over the most recent cocoon.

Each cocoon is a flattened disk of rather loose white threads, and the mode of architecture shows that the mass of ova had been laid upon the surface of the lower disk (base), and then overspun with another disk (cover). But a peculiarity is a third disk of silk, concentric with but at a distance of about 2 mm. from the cover of the cocoon—the final protection, on which the mother stands.

Prosthesima sp.[3]

Cocooning.—On June 14, at 8.45 P.M., I saw a female just finishing her cocoon, which was discoidal in shape. She placed her feet upon its margin, and brushed her spinnerets from side to side across its surface. This was her second cocoon, and at 10.05 she started spinning again upon the wall of the cage, used her spinnerets as before, and continuing steadily up to 11.50, when I ceased to watch her. She had then made a thick silken covering, about four times her length in one direction, and half so long in the other. But she did not oviposit upon this surface, so that I cannot tell whether it was an abnormal cocoon or not.

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[3] Mr. Banks wrote me that this species comes closest to *P. insularis* Banks, but is different from it.

Thargalia brivittata (Keys.).

Cocooning.—The end of this process only was seen. The discoidal cocoon was satiny-white and placed at the angle of the floor and wall of the cage; its base was closely apposed to these surfaces so as to be bent at a right angle, while the cover (of smaller diameter than the base) was arched from the floor to the wall. In completing this cover the spider brushes her spinnerets more forward and backward than from side to side, flexing her body about energetically, while keeping her feet in one position upon the edge of the cocoon; then she changes her position over the cocoon, and repeats this process. I watched her in this process for half an hour, after which she covered the surface of the cocoon with small particles of dirt.

Drassus neglectus Keys.

Guarding of the Cocoon.—A female of this species was caught on June 10, and made a thick web within her cage. On the evening of July 7 she made her cocoon, which was white in color, discoidal with circular outline, one side flattened and the opposite side somewhat arched. This cocoon was loose, not fastened to any object, and she held its margin with her chelicera, pressing her cephalothorax against it and at times partially embracing it with her legs. Most of the time she held it in one corner of the cage, but sometimes carried it about to different portions of the cage. When I touched her she still clung to it without moving; flies were put in her cage almost daily, but she paid no attention to them, even though at times they touched her. She died on July 21, still holding the cocoon in death.

This observation is narrated, since I know of no other Drassid that guards its cocoon so carefully, nor of any that makes such a thick and large web.

General Considerations.

History of Our Knowledge.—In 1701 Leeuwenhoek, the father of histology, wrote: "I never was so happy as to see the Spiders couple, ... but what shall we say, the Coition of Spiders must differ fundamentally from other Creatures, since their Matrix is placed in the upper part of their Belly." He did not know of the observations of Lister, who in 1678 discovered that the male spider fertilizes the female by applying the enlarged terminal joint of his maxillary palpus to her epigynum. The discovery has been confirmed by a long list of observers, though a list small in comparison with the number who have sought in vain to see the process: Ausserer, Bertkau, Blackwall, Campbell, Clerck, De Geer, Dugès, Emerton, Fickert, Hasselt, Hentz, Her-

man, Lendl, Lesser, McCook, Menge (in numerous species), the Peckhams, Ritsema, Seidel, Treat, Walckenaer, Westberg. These confirmatory observations, embracing species of all the larger araneid families, make it very probable that in all modern Araneids the male transfers the sperm to the female by means of his palpi. Two writers have combated this conclusion: Treviranus, who first discovered the testes of spiders and, finding no organic connection between these organs and the palpi, maintained that the application of the male palpi to the epigynum is probably not real copulation, but rather a preliminary act of stimulation; and Cambridge, who states he observed two individuals of a *Lycosa* in coition, with their genital apertures in apposition. In view of the numerous observations on this act in *Lycosa*, I have no hesitation in stamping Cambridge's assertion as erroneous. In all the families where the act has been seen, accordingly, the palpal organs are the transmitters of the semen.

Now though Treviranus showed conclusively that there is no organic connection between the testes, or the vasa deferentia, and the peculiarly modified palpal organs, some later writers, particularly Cambridge and Herman, insisted that there must be some such tubular connection, in order to explain the presence of spermatozoa in the palpal organs. The results of all other anatomists, however, have corroborated Treviranus, and Menge discovered, first in the year 1843, how the sperm is brought from the genital aperture into the tubular apparatus of the palpal organs. In that paper of 1843, an arachnological classic, he described the process for *Linyphia triangularis* and *Agalena labyrinthica*, showing that the male constructs a little silken bridge or "Steg," deposits a drop of sperm from his genital aperture upon it, then applies his palpal organs alternately to the drop until they have absorbed it all; then, and not till then, is the male ready for copulation. This process of charging the palpi with sperm, which I have termed here "sperm-induction," was described by Menge later also for *Tapinopa longidens*, *Agalena similis* and *Micrommata virescens*. The only other writers who have described this process are Blackwall (1863, in *Agalena labyrinthica*), Ausserer (1867, in *Dictyna benigna* and *Linyphia triangularis*), Bertkau (1875, 1876, in *Philoica domestica*, *Linyphia montana* and *Clubiona comta*), Westberg (1900, in *Linyphia triangularis*). To these may be added my present observation on *Lycosa stonei*, *L. ocreata pulchra*, *Tegenaria derhami*, *Theridium tepidariorum* and *Dictyna volupis* (here seen twice). Hasselt was unable to see this process himself, and on that account doubted whether it is of general occurrence among spiders.

The Mode of Embrace in Copulation.—Grouping together my own observations with those of other naturalists, and bracketing the authority for each case, the following modes of embrace may be distinguished in spiders:

(1)——The male above the female with his ventral surface apposed to her dorsal, their heads pointing in opposite directions,

(a)—Female with her sternum down: *Lycosa stonei*, *L. ocreata pulchra*, *L. scutulata* (Montgomery), *L. monticola* (Clerck), *L. amentata*, *L. rurestris* (Menge); *Trochosa infernalis* (Lendl), *T. terricola* (Menge); *Pardosa nigropalpis* (Montgomery); *Sparassus* (Bertkau); *Epiblemum scenicum*, *Attidæ*, *Enophrys reticulata* (Menge), *Attus scenicus* (De Geer); *Phrurolithus festivus*, *Melanophora nocturna* (Menge).

(b)—Female partially upon her side: *Agalena nævia* (Emerton, Montgomery), *A. labyrinthica* (Dugès, Menge, Walckenaer), *A. similis* (Menge).

(2)——The head of the male facing the head of the female, their bodies in one line,

(a)—Male with his dorsum directed upward, female partially upon her side: *Tegenaria derhami* (Montgomery).

(b)—Both with ventral surfaces directed upward, bodies horizontal: *Linyphia marginata* (Emerton, McCook), ?*Steatoda borealis* (Emerton).

(3)——Ventral surfaces of the pair apposed, sternum against sternum, heads directed in opposite directions,

(a)—Copulation upon a web: *Argenna* (Bertkau), *Linyphia montana* (Clerck), *Linyphia triangularis* (De Geer, Menge).

(b)—Copulation upon the ground,

(b′)—Male below the female: *Argyroneta aquatica* (Walckenaer), *Chiracanthium oncognathus* (Menge).

(b″)—Male above the female: *Clubiona trivialis* (Menge).

(4)——Male holding to the side of the abdomen of the female, his long axis at right angles to hers: *Acrosoma gracile* (Montgomery).

(5)——Male with his ventral surface apposed to the posterior and ventral surface of the abdomen of the female, their heads turned in the same direction: *Xysticus audax* (Prach), *X. triguttatus* (Emerton), *X. stomachosus* (Montgomery), *Misumena vatia* (De Geer), *Micrommata virescens* (Menge).

(6)—Ventral surface of the male turned toward the ventral surface of the female, their heads turned in the same direction, copulation in a web,

(a)—Bodies not in actual contact, but heads converging: *Epeira labyrinthea* (Montgomery), *E. diademata* (Menge, Lendl), *Theridium tepidariorum*, *Pholcus phalangioides* (Montgomery).

(*b*)—Long axes of the bodies converging so that the forehead of the male touches the sternum of the female: *Dictyna volupis* (Emerton, Montgomery), *D. benignum* (Walckenaer), *Micryphantes rurestris* (Hasselt).

(*c*)—Male with his sternum apposed to that of the female: *Dictyna ammophila* (Menge).

(*d*)—Male apposed to the ventral surface of the abdomen of the female: *Nephila*, *Argiope* (Emerton), *Meta segmentata*, *Asagena serratipes* (Menge).

(*e*)—Male holding the chelicera of the female with his own, the abdomen of the female flexed ventrad: *Pachygnatha listeri* (Menge), *Tetragnatha extensa* (Bertkau, Dugès, Menge, Lister, Walckenaer).

The following table illustrates the distribution of these modes of embrace among the families observed:

Family.	Mode of Embrace.												
	1*a*	1*b*	2*a*	2*b*	3*a*	3*b*	4	5	6*a*	6*b*	6*c*	6*d*	6*e*
Lycosidæ	+												
Sparassidæ	+												
Attidæ	+												
Drassidæ	+					+							
Agalenidæ		+	+										
Theridiidæ				+	+				+			+	
Argyronetidæ						+							
Epeiridæ							+		+			+	+
Thomisidæ								+					
Pholcidæ									+				
Dictynidæ										+	+		

The species which have been observed are too few to allow broad generalizations, but the following points may be noted. In all the species it is the male that embraces the female, she remaining motionless; the male embraces with his legs, and in *Tetragnatha* and *Pachygnatha* with his chelicera also. The mode of embrace may well be dependent upon one of several different factors: (1) relative size of male and female; (2) differences in their form; (3) differences in place of copulation (whether upon a web or upon the ground). The fact that the typical terrestrial spiders which do not build webs (*Lycosidæ*, *Sparassidæ*, *Attidæ*, certain *Drassidæ*) all show the same mode of embrace might point to similarity of place of copulation, in unison with the running and hunting habits of these species, inducing similarity of mode of embrace, and be referable to the third factor;

while the diversity of embrace in the web-making species may be in part due to differences in the web construction, in part to degree of sexual dimorphism. The *Epeiridæ* and *Theridiidæ* show the greatest diversity of embrace, and in these families is to be found also the greatest sexual dimorphism. In other words, the mode of embrace may be brought into more or less conformity with the general mode of life of the species. Similarity of embrace points, then, to similarity of other habits, but not necessarily to community of descent. No spider shows the attitude of embrace common among insects, namely the male above the female with his head pointed in the same direction as hers.

Details of the Process of Copulation.—The following table combines data of the other observers with my own upon the details of copulation. Where a species has been entered more than once, each repetition denotes a separate act of copulation. In the column "Duration of Copulation," *h, m, s,* signify *hour, minute* and *second* respectively. In the column headed "Simultaneous," the sign × denotes that both palpi are inserted at once, and the sign — that they are not. In the column headed "Alternated," the sign × indicates that the right and left palpi are inserted alternately, but that the number of alternations was not noted; the sign —,that only one palpus is employed; while a number expresses the number of alternations of the right and left palpi. In the columns headed "Right Palp" and "Left Palp," a number enclosed in brackets denotes the average number of times one palpus is inserted successively before the other palpus is inserted, this average being obtained by dividing the total number of insertions of that particular palpus by the total number of alternations of the palpi. Spaces left vacant in the columns denote lack of observations. For the great number of small details that cannot be reproduced in such a table, the reader is referred to the observational part of this paper, and to the works mentioned in the literature list.

Family	Species.	Authority.	Duration of Copulation.	Application of Palpi.		Number of Palpal Insertions.		
				Simultaneous.	Alternated.	Total Number.	Right Palp.	Left Palp.
LYCOSIDÆ.	*Lycosa stonei*	Montgomery	13 m.	—	12	105	48 (4)	57 (4.7)
	Idem	*Idem*	1 h. 15 m.	—	12	126	53 (4.4)	73 (6)
	L. ocreata pulchra	*Idem*	47 m.	—	8	64	31 (3 9)	33 (4.1)
	Idem	*Idem*	1 h. 27 m.	—	15	140	68 (4.6)	72 (4.8)
	L. scutulata	*Idem*	59 m.	—	42	98	52 (1.2)	46 (1)
	Idem	*Idem*	55 m.	—	81	167	85 (1)	82 (1)
	L. lugubris	Blackwall	4 h	—	+	Several hundred		
	Idem	*Idem*		—	+		80	80
	L. rurestris	Menge		—	+		(6)	(6)
	L. amentata	*Idem*	7 h.					
	Pardosa nigripalpis	Montgomery	9 m.	—	+			
	Idem	*Idem*	7 m.	—	1	24	6 (6)	18 (18)
	Trochosa infernalis	Lendl	65 m.	—	+	109		
	T. reticulata	Menge	3 h.	—	+			
EPEIRIDÆ.	*Acrosama gracile*	Montgomery	8–10 m.	—	—	1		
	Epeira labyrinthea	*Idem*	5 s.	+?				
	E. diadema	Ausserer	A few seconds					
	E. quadrata	Herman	36 h.					
	E. callophylla	Walckenaer	20 m.	—	+			
	E. marmorea	Menge	1 s.					
	Tetragnatha extensa	Dugès	15 m.	—	+			
	Idem	Menge	1 h.	—	+			
	Meta segmentata	*Idem*	Several minutes	—	—			
	Pachygnatha listeri	*Idem*	3 h.	—	1			
THERIDIIDÆ.	*Theridium tepidariorum*	Montgomery	5–15 s.	+	—	1	1	1
	T. quadripunctatum	Menge	2 h.	—	1			
	Linyphia triangularis	De Geer, Menge, Westberg	2 h. 30 m.	—	Every 10 s.–3m.30s			

	Species.	Authority.	Duration of Copulation.	Application of Palpi.		Number of Palpal Insertions.		
				Simultaneous	Alternated.	Total Number.	Right Palp.	Left Palp.
THERIDIIDÆ.	*Linyphia marginata*	McCook	2 h. 55 m.	+	+			
	Steatoda borealis	Emerton	1 h. 15 m.					
	Stylophora concolor	Menge	2 h.	—	+			
	Tapinopa longidens	*Idem*	4 h.	—	+			
	Asagena serratipes	*Idem*	1 h.	—	—	1		
	Eucharia bipunctata	*Idem*	2 h. 30 m.	—	—	1		
DICTYINIDÆ.	*Dictyna benigna*	Ausserer	30 m.	—	6	6	3	3
	D. ammophila	Menge	2 h.	—	+	4	2	2
	D. volupis	Montgomery	At least 1 h.	—	—	1		1
	Idem	*Idem*	At least 50 m.	—	—	1		1
	Idem	*Idem*	51 m.	—	—	1	1	
	Idem	*Idem*	At least 34 m.	—	—	1	1	
	Idem	*Idem*	2 h. 18 m.	—	1	2	1	1
	Idem	*Idem*	At least 1 h. 16 m.	—	1	2	1	1
	Idem	*Idem*		—	—	1		1
	Idem	*Idem*		—	—	1		1
AGALENIDÆ.	*Tegenaria derhami*	*Idem*	5 s.	—	—	1		
	Idem	*Idem*	1 m.	—	—	1	1	
	Idem	*Idem*	2 m. 45 c.	—	2	3	2	1
	Agalena similis	Menge	3 h.	—				
	A. nævia	Montgomery	7 h. 45 m.	—	2	3		
	Idem	*Idem*	More than 8 h.	—	1	More than 53	More than 22	31
	Idem	Emerton	Several hours	—	1			
	A. labyrinthica	Bertkau	1 h.	—	1	60–80	30–40	30-40
	Idem	Menge	More than 3 h.	—	1			
DRASSIDÆ.	*Melanophora nocturna*	*Idem*	At least 30 m.	—	1			
	Phrurolithus festivus	*Idem*	3 h.					
	Chiracanthium oncogathus	*Idem*		—	1		15 m. at a time	15 m. at a time
	Clubiona trivialis	*Idem*	Several hours					

Family	Species.	Authority.	Duration of Copulation.	Application of Palpi.		Number of Palpal Insertions.		
				Simultaneous	Alternated.	Total Number.	Right Palp.	Left Palp.
ATTIDÆ.	*Heliophanes cupreus*	*Idem*	30 m.	—	—?			
THOMISIDÆ.	*Micromata virescens*	*Idem*	5 h.	—	+		30 m. at a time	30 m. at a time
	Xysticus audax	Prach		—	+			
	X. stomachosus	Montgomery	27 m.	—	3	23	17	6
	Idem	*Idem*	25 m.	—	—	12	12	
	Idem	*Idem*	28 m.	—	—	14		14
	Idem	*Idem*	48 m.	—	6	33	17	16
	Idem	*Idem*	34 m.	—	6	17	10	7
	Idem	*Idem*	25 m.	—	5			
PHOLCIDÆ.	*Pholcus phalangioides*	*Idem*	32 m.	+	—	2	1	1
	Idem	*Idem*	More than 25 m.	+	—	2	1	1
	Idem	*Idem*	About 26 m.	+	—	2	1	1

From these data we may conclude:

(1) That the time duration of a copulation varies from a second, or a few seconds, to as much as 36 hours. When the copulation is very brief it is probably frequently repeated many times, a number of times in quick succession (as certain Epeirids), or repeated a number of times on successive days (cf. my observations on *Theridium tepidariorum*). When it is of some hours in duration, the female frequently, but not always, kills the male at its conclusion (certain Lycosids and Agalenids).

(2) That the simultaneous insertion of both male palpi in the epigynum is unusual (*Pholcus*, certain Theridiids). Most frequently either (*a*) only one palpus is used during the act, or (*b*) the palpi are alternated; sometimes the same male may use only one palpus during one copulation, and both palpi during another (*Dictyna volupis, Xysticus stomachosus*). When the palpi are alternated, either (*a*) one of them may be used (continuously or with successive insertions) during the first half of the copulation, and the other palpus for the second half; or (*b*) the palpi may be frequently alternated, a strict alternation of right and left after each insertion, or else one may be inserted a number of times before the other is used.

(3) That in all cases described in sufficient detail there has been noted the appearance, during insertion in the epigynum, of an evaginated, swollen sac connected with the palpal organ; the organ is not withdrawn from the epigynum until this sac collapses; this sac may expand and contract rhythmically in long insertions. After the withdrawal of a palpus from the epigynal orifice, the male works the palpal organ between his chelicera—apparently to moisten it, as has been suggested by one observer.

(4) That within a species there is to be found considerable individual variations in the details of copulation.

(5) That a particular araneid family, as at present defined, may contain species which differ quite markedly in the details of their copulation: the *Epeiridæ* are an example.

The Sperm-induction, and the Origin of the Araneid Mode of Copulation.—In the section entitled "History of Our Knowledge" all the known cases of sperm-induction are mentioned. In all these cases the male deposits a minute drop of semen upon a portion of web, and takes up this drop into his palpal organs by applying the latter to it, then shaking them in the air. There appear, however, to be some difference in the details in different species. Thus the male sometimes spins a special small sheet or bridge over which he stands, and on

which he deposits the semen (*Linyphia triangularis, Agalena labyrinthica, Tapinopa longidens, Agalena similis, Micrommata virescens, Dictyna benigna, Philoica domestica, Linyphia montana, Clubiona comta, Lycosa stonei, L. ocreata pulchra, Tegenaria derhami, Dictyna volupis*); and sometimes he makes no special sheeting, but deposits the semen upon a strand of the domicile web (*Theridium tepidariorum*). In those species where the male does not construct a domicile web, but lives upon the ground, as in the *Lycosidæ* and *Drassidæ*, the male always spins a small sheeting to catch the drop of semen, and this is his only spinning act during his mature life; species that live in webs also generally construct a special sheeting for the semen. There is no known case of the male charging his palpi by placing them directly against the genital aperture. In order to see this act the observer should remove the male from the female immediately after a completed copulation, one which has exhausted the palpi of the seminal fluid, and watch for an act of sperm-induction; that is the only time when one may expect it with some certainty. In some species the male may copulate several times, and frequently charges his palpi with semen before repeating an act of copulation.

This is a very wonderful process: the male discharges semen upon a web, takes up this semen into his palpal organs, and with the latter applies the semen to the genital aperture of the female. There are, in a sense, two separate acts of seminal discharge, and at each of them, but most particularly in the second, the male shows very evident gratification. No one, to my knowledge, has endeavored to account for such a double process, which is essentially different from the "hektocotyly" of Cephalopods. It is definitely determined that the palpi (pedipalpi) of araneids and other arachnids have, in the mature state, no organic connection with the testes or vasa deferentia, that there are no tubes connecting the palpal organs with the organs in which the spermatozoa develop. In the ontogenetic development the palpi appear at first similar to the other extremities, and are separated from the genital aperture by four segments of the cephalothorax, each bearing a pair of appendages. Accordingly there is neither anatomical nor embryological reason for supposing that the palpi ever had been appendages of the genital aperture, which had later moved forward from the region of the genital aperture; they are true thoracic appendages, and not abdominal. Now the pedipalpi of *Limulus* in the male terminate each in a large swollen knob, which is used in the copulation as a clasper of the female; and in *Limulus* the distal end of each of these swollen joints opens to the exterior by a minute aperture, which

is readily determined on dissection. The fact that *Limulus* is a true arachnid, and probably a relatively primitive one, allows us to use these peculiarities of structure as a partial basis for explaining the araneid mode of copulation; though the following reasoning would hold equally good, even if *Limulus* should be left out of the question. The palpal organs of male araneids must have been originally clasping organs, to hold the female. Supposing the terminal joints of the male palpi clasped the female in the region of her genital aperture, around which developed a hard chitinous plate, the epigynum, which would allow a firm hold without injury to the female, then if the original mode of embrace were that where the ventral surfaces of the copulating individuals were apposed, these two suppositions would explain the copulation of modern araneids. Depressions in the epigynum would be developed to correspond to projections upon the palpal organs. The surfaces of the palpal organs, which are apposed to one another during the act of clasping, could become in time so modified as to form together a tube to guide the seminal fluid from the genital aperture of the male into that of the female. They would thus change from mere clasping organs to intromittent sexual organs, and then perhaps the other legs come into use as clasping organs, which is their use in copulation in modern araneids. Subsequent would be the development of the complicated tubular apparatus within each palpal organ; and when this were finally developed, the habit of charging the palpi with sperm before the copulation would be involved, and then diversity in embrace and modes of application of the palpi could follow.

There is still another thinkable mode of origin of the araneid mode of copulation. The pedipalpi might be used, not as claspers in the first instance, but to carry drops of semen during the act of copulation from the genital aperture of the male to that of the female; later, the male during copulation might discharge his semen upon the web, and then take up the semen with his palpi and apply it to the female; still later, the charging of the palpi with the semen would come to be an act separate from the copulation.

One or the other of these has been probably the mode of origin of the habit, but which cannot be decided until observations have been made upon the mating of the most primitive living araneids, the *Tetrapneumones*. Very apposite in this connection are the interesting and detailed observations of my friend Heymons[4] upon *Galeodes*. In this primitive arachnid the male forcibly seizes the female, holds

[4] "Biologische Beobachtungen an asiatischen Solifugen," *Abh. Preuss. Akad. Wiss.* Berlin, 1901.

her with her legs, she falling into a state of torpor in his embrace. With his chelicera he pinches the ventral surface of her abdomen, which is turned toward his, until he finds the cleft of her genital orifice. "Die Cheliceren werden herausgezogen, nochmals eingebohrt, und das Männchen kneift auch wohl wiederholt mit denselben in die weichen Wandungen des Ostium genitale. Es dauert nicht lange, so tritt die ganze weibliche Genitalpartie wulstförmig hervor, und die Genitalöffnung wird als ein klaffender Spalt erkennbar. Die Erregung des Männchens hat nunmehr den Höhepunkt erreicht; zitternd bewegt es beide Maxillarpalpen und hebt den Hinterleib ein wenig, aus dessen Genitalöffnung ein zähflüssiger klebriger Spermaballen hervorquillt. Kaum ist dieser auf den Boden gelangt, so wird er auch schon blitzschnell von den Cheliceren des Männchens aufgenommen und an die weibliche Genitalöffnung gebracht. Hierauf stopft das Männchen, abwechselnd die rechte und linke Chelicere benutzend, die zähe Spermamasse in die Oeffnung hinein, wobei es wieder mit grosser Gewaltthätigkeit zu Werke geht." The process is simpler in *Galeodes*, inasmuch as the sperm is discharged during the act of copulation, and inasmuch as the terminal joints of the chelicera do not possess any intricate tubular apparatus for holding the sperm. But the araneid copulation cannot be derived from the galeolid, since in the former the pedipalpi, in the latter the chelicera, are employed. In the *Acarina* and *Scorpionidea* there are intromittent organs (penis) in the male, placed near the genital orifice.[5]

Number of Copulations.—In araneids the male is able to perform a number of successive copulations, with the same or with different females, without being exhausted; this fact may be brought into relation with the fact that before each act of sperm-induction only a small drop of sperm is discharged, and by no means the whole contents of the testes. One act of fertilization is in some cases sufficient to fertilize a number of cocoons, yet not infrequently several distinct copulations may precede one cocooning. This is in contrast to the case in insects, where the male generally performs a single act of copulation, and dies of exhaustion after it. The female sometimes kills the male after copulation, but this is by no means so general as usually supposed,

[5] In all insects the intromittent organ of the male is organically connected with the vas deferens, except in the *Odonata* where, as is well known, this organ is placed on the second abdominal segment, and the male holds the head of the female with the claspers of his last abdominal segment. My colleague, Dr. P. P. Calvert, the well-known monographer of the *Odonata*, tells me that he has seen the male charge his penis with semen just before copulation by bringing his sexual orifice against this organ.

for frequently both sexes may live in harmony for a considerable length of time. The reason that in many species the females appear more abundant than the males (particularly in *Epeiridæ*), is not to be ascribed to any initial disparity in the number of the sexes, nor yet to the males being killed by the females, but to the females being of stronger constitution. Thus, in the case of the individuals watched by me, the males died sooner from hunger and thirst than did the females, and each act of copulation appeared to diminish their vitality. When one collects in the early part of the mating season the males are generally found fully as abundant as the females, while later in the year they may become, in some species, very rare.

Parthenogenesis.—Two cases of apparent true parthenogenesis, with the production of fertile eggs, have been described by Campbell (1883) and Damin (1893). A number of females observed by Blackwall (1845), where he excluded males and kept the females through a number of moults, made cocoons and laid eggs, but the latter proved infertile. Eggs frequently prove infertile even after copulation, according to my own observations. Parthenogenesis, with the production of fertile eggs, is then very rare among spiders, and it is probable that most species do not show it at all. Blackwall's observations (1845*a*) are quite decisive upon this point.

A very curious case is that described by Doumerc (1840) of a *Theridium triangulifer* which made successive cocoons, out of some of which only male spiderlings developed, out of others only females. This is a phenomenon well worth critical study.

Cocooning, Oviposition.—I shall not attempt to give here a comparative study of cocoon-architecture; that subject has been well treated by Wagner, and much less accurately by McCook; but shall simply call attention to the similarity that exists among all observed species in the general modes of cocoon-making and oviposition. The first stages of this process have not been frequently described, and the following list comprises all the observations on the subject: Leeuwenhoek, Menge (*Lycosa, Tegenaria, Gnaphosa, Micaria, Philodromus*), Emerton (*Epeira*), McCook (*Lycosa*), Henking (*Lycosa*), Pokrowsky (*Pholcus*), Warburton (*Agalena*), Wagner's excellent studies on a number of species, and my own (*Lycosa stonei, L. lepida, L. punctulata, L. ocreata pulchra, Pardosa nigripalpis, Pirata liber, Tegenaria derhami, Theridium tepidariorum, Teutana.*). In all of these the spider spins first a base, oviposits upon it, then spins a cover over it; all araneid cocoons are made in this way. McCook (1890) distinguishes three kinds of cocoons, and states of the third kind (supposed to be

characteristic of the *Lycosidæ*): the spider spins "a single sheet, within which the eggs are deposited, which is subsequently pulled over the egg mass, and pinched by the jaws into a globular covering, the selvage of which is united with sufficient firmness to adhere until the spiders are ready to leave the cocoon." As a matter of fact, such a type is not known among spiders. McCook had based it upon an imperfect observation of his own (in 1884); Menge had described the process in *Lycosa* correctly as long ago as 1843, and Henking, Wagner and I corroborate Menge, that the cocoon is made in the *Lycosidæ* of two separate portions, a base and a cover. No matter what the final shape of the cocoon may be, nor how the mother places or carries her cocoon, it is always made of two separate portions. These may each be a disk (*Lycosidæ, Drassidæ, Thomisidæ, Dictynidæ, Agalenidæ*), or the base may be a spherical ball of silk (some *Theridiidæ*). The mode of oviposition also appears to be uniform in araneids; the eggs are discharged upon the base of the cocoon included in a large drop of fluid of very viscid consistency; this drop serves to retain the ova in a compact mass, and to protect them from the air before the cover of the cocoon is made. This drop of fluid is of such bulk that only a small portion, if any, of it can consist of semen, and it is probably a secretion of glands connected with the female generative apparatus. Bertkau was unable to find spermatozoa within this fluid.

The act of oviposition does not weaken the spider, and in some species one individual produces a number of cocoons in succession. Females have been known to live for several years.

Care of the Cocoons and Young.—The *Lycosidæ*, as is well known, carry the cocoon attached to the spinnerets, and carry the young upon their bodies for some time after hatching; but the mother does not feed the young, as Kirby supposed. The Lycosid genera *Dolomedes* and *Ocyale*, however, carry their cocoons in a different manner and build a nest for the young. I have seen also that the mother bites open the cocoon to allow the escape of the young. Many of the *Thomisidæ* also guard their cocoon, embracing it for long periods at a time, as has been observed in *Thomisus, Olios* and *Xysticus*. Some Theridiids also guard their cocoons and carry them about; there is a very remarkable case of maternal solicitude described by Kathariner for *Stegodyphus lineatus;* and Seidel states that all the Theridiids which carry their cocoons about bite them open to allow the escape of the young. The Attid *Salticus* has also been described as a cocoon-guarder. One Drassid I have found to hold her cocoon and carry it about. *Pholcus* is also a well-known example, holding her cocoon in

her jaws, but she does not remain holding it continuously until it hatches, but I have found will hang the cocoon upon the web in order to feed and to clean herself. McCook has given a broad general account of the degrees of maternity among spiders, and I will go into the subject here no further than to state that in most families and species there is no marked maternal solicitude for the cocoons and young. The case of the *Drassidæ*, when the female is generally found near her cocoon, is not a case of maternal solicitude, but the mother remains near the cocoon because she chanced to place it in her narrow domicile; an exception is found in *Drassus neglectus*, described in the preceding pages.

Courtship.—It is difficult to define what has been called "courtship" in animals; a general definition would be: the performance, immediately preceding the copulation, of peculiar motions by the male. But this is hardly an adequate definition, for an eager male always acts differently in the presence of a mature female than he does at other times. We should then have to say "a rhythmically repeated set of motions on the part of the male, continued for some time before copulation."

Using the idea of courtship in this sense, we find a courtship in two families of araneids, each of whom construct no webs, namely, the *Attidæ* and the *Lycosidæ*. The courtship of the *Attidæ* has been described for a considerable number of species by the Peckhams, and these authors have studied it particularly with regard to the relative value of the theories of Sexual Selection expressed by Darwin and Wallace. They find the courtship of the Attids to consist sometimes in dances, sometimes in remarkable posturings, sometimes in a waving of the legs or palpi by the male; and they interpret these motions as in each case an exhibition before the female of bright colors and peculiar structures by the male. The *Attidæ* are the most brilliantly colored of all the spiders, and some of them evince courtship motions to a degree not shown by any others. Menge and Treat have briefly noted courtship motions among *Lycosidæ*, and I have described them in the earlier part of this paper for *Pardosa nigropalpis*, *Lycosa stonei*, *L. lepida* and *L. scutulata*. Without repeating the details of the observations, it may be stated that the actions of the male consist in a rhythmical motion of the first pair of legs (waving in the air or tapping upon the ground), sometimes accompanied by waving of the palpi.

I have not found in my own studies, nor do I find in the observations of others, indications of true courtship in any other araneid families. To be sure, in web-makers like the *Pholcidæ*, *Theridiidæ* and *Epeiridæ*,

the males communicate signals to females, and are answered by them, by pulls upon the web-lines connecting the two individuals. And in some *Agalenidæ*, as *Tegenaria derhami*, the males approach the females very slowly at first, tapping upon the horizontal sheet of the web with their palpi and first pair of legs. But such motions on the part of the male should be interpreted rather as signals of the male to determine the sex and the degree of eagerness in his partner, than as a courtship proper. Similar are the approaches of the Dictynids. The male in the *Thomisidæ* (*Xysticus stomachosus*) makes no preliminary motions whatsoever, but as soon as he touches the female seeks to immediately mount upon her back.

The question of the psychology of courtship among animals is a very great one. How, in the first place, does one sex recognize the other as such? One of the greatest wonders in the study of animal habits, though it is so general that its strangeness is overlooked, is that one individual, before it has once experienced an act of union with an individual of the other sex, has the sense that that other individual can gratify its desire, and can unerringly perform that act. In the spider it is still more remarkable, for the male has first to perform the act of charging the palpi with sperm. This is no act of mere automatism; here the animal shows most truly that it cannot be compared with a machine. "Gonotropism" is a mere name and does not explain nor classify the process. Broad questions like this one must be elucidated before we can hope for any adequate explanation of courtship, a performance of secondary importance, and consequently I would call attention here merely to certain peculiarities in the courtship of spiders.

In the first place, courtship is primarily an expression of eagerness upon the part of the male. The male is mature, and the recognition of the opposite sex in a state of maturity also stimulates him to the excess of desire. It may be at first a mental state, which then reflects upon the organization and perturbs the latter. Great excitement finds expression in muscular activity, and hence the peculiar, exaggerated movements corresponding to an abnormal state of stimulation. In some animals the male, once so excited, rushes at the female; in other he does not do so immediately, but goes through a preliminary set of motions, which may be termed courtship when they are regular and more or less rhythmical. Now in the case of the araneids, why does not the male immediately hasten to the female, since by so doing he would most quickly gratify his desire? Several answers might be suggested: (1) that the male seeks to reach the highest pitch of excitement, or waits until that state is reached, before approaching the

female—having, as it were, a pleasure in the state of excitement itself; or that (2) he strives first to assure himself of the eagerness of the female; or that (3) he strives first to stimulate the female to equal eagerness. The first of these answers probably accounts for a certain part of the delay before the act of coition, but not for all of it. The second answer, I think, accounts for the remaining part of the delay, while the third answer is hardly admissible, and for the following reason: Deep-rooted in every spider is caution in approaching another individual, particularly upon a foreign web (and in web-making species the male always approaches the female upon her own web). This is well marked in Epeirids; the male approaches and retreats many times tentatively until he assures himself, by the female remaining quiet, that she is not hostile to him. A decided attack by the female, and I have found the male to generally cease his approaches. His peculiar motions during his approach, be they courtship or not, are referable to his excitement. The approach is then marked by a combination of fear and of intense excitement, more or less restrained by this habit of fear. Certain attitudes of the male, in the *Attidæ* particularly, as the Peckhams have demonstrated, are such as to exhibit most clearly before the female sexual beauties or eccentricities of form or color. But the point which I wish to emphasize is, that there is no evidence that the male is conscious of exciting the female thereby; by such motions and attitudes she certainly recognizes him as a male, and perhaps is herself stimulated to a state of sexual desire, but the male does not carry out these performances in order to stimulate her.

In the Lycosids with a decided courtship, a part of the courtship is a straightening out before him of his first pair of legs by the male, and then a withdrawal of them. But this is only an exaggerated performance of motions that he exhibits in other mental states; these legs are his main organs of touch as he walks, and also his main organs of guard; they are used similarly by the female. Each sex, in answer to an act of hostility, elevates these legs and directs them forward. Here is an act of caution, and the male in courtship simply exaggerates the expression of this act. Now in two of our American species, *Lycosa ocreata* and *Lycosa stonei*, the tibiæ of this pair of legs are thickly furred with black hairs, making them very conspicuous. In *Lycosa stonei* the male in his courtship waves these legs so as to show their furring to the female, but waves them in approximately the same manner as do Lycosids which possess no such secondary sexual ornaments. But the male of *L. ocreata* does not wave these

legs. Certain Attids, according to the account of the Peckhams, exhibit courtship motions of such a very bizarre nature that they would seem at first sight as not referable to movements shown when the male is not sexually excited; yet some of them may be found to be excessive expressions of some of the latter group of movements.

Thus the motions of the male in courtship are to be directly explained as a muscular expression of his intense eagerness, of vitality in its highest state; though some, at least, of these motions are merely exaggerated repetitions of movements which he performs under other conditions. Such performances probably do stimulate sexual eagerness in the female, by advertising the performer as a male; but there is no evidence that the male consciously performs for that end. It is as a man under the influence of strong drink: smiles are produced by his antics, but he does not consciously occasion the smiles.

The male alone does not make all the approaches, but sometimes the female likewise. Thus in *Lycosa scutulata* the female taps the male with her legs when she is willing for copulation, and the females of the other Lycosids studied by me bend their heads down to the ground as a similar indication. The female of *Theridium tepidariorum* signals very energetically to the male, by repeated pulls upon the web-lines, and appears to be first in the courtship. Other females, as of the *Pholcidæ* and some *Epeiridæ*, give no active expression of readiness, but by remaining perfectly quiet, thereby not showing hostility, assure the males of their willingness. The only case I know of when the male seizes the female by storm is *Tegenaria derhami*. Since the male ceases his courtship as soon as the female gives the signal of desire on her part, very plainly a portion of the delay before the copulation is due to the male testing the eagerness of the female.

Sexual selection may well be, in some cases, the process which has occasioned secondary sexual differences, and in the case of the spiders the view of the Peckhams in this matter is probably correct. That is to say, the differences in the males are due, not to "greater vitality" of the male sex, but to selection by the females. Yet I would make the point that there is no evidence that the females are influenced by any æsthetic sense of the beautiful in males—that the females do not select males that seem most beautiful to them; but that they select those males which, by peculiarities in movements, color or form, most quickly and certainly announce their sex. Other things being equal, the male that is most eager would be most active in his courtship motions, and would stand the chance of being selected by the expectant female, since he would be advertising his sex most prominently;

and not because he would appeal to her as more beautiful or graceful than other males.

These views as to the origin and meaning of courtship in spiders may be briefly summarized as follows: The mature male is stimulated to great excitement by a perception, visual and tactual, of a mature virgin female, and this excitement finds its expression in muscular movements. The male does not immediately embrace the female, for in most spiders he is the weaker individual, but delays in order to first determine whether the female is eager or hostile. Rhythmically repeated motions of the male during this period of delay constitute courtship, and these motions are for the most part exaggerations of ordinary motions of fear and timidity. By such motions he advertises himself to the female as a male, but there is no proof that he consciously seeks to arouse her eagerness by æsthetic display. That male is accepted by the female who most quickly and surely announces himself, by his rhythmic movements, to be a male; and there seems to be no good reason to hold that the female is actuated in her choice by sensations of beauty. If such a process be interpreted as sexual selection, it would be a selection of the male who most determinedly announces himself to be a male, and not as the male who appeals to the female as the most beautiful.

Post-nuptial moult.—It is generally believed that in araneids the final moult precedes the mating. But Bertkau (1885) has shown that in *Atypus piceus* a moult, with change of the seminal receptacles, occurs after the first year of oviposition; and I have described here for *Lycosa ocreata pulchra* a moult following a successful copulation. Accordingly, in some cases a moult may follow the mating; and probably this will be found to be general in species that live several years, since increase in body size occasioned by rich feeding would appear to necessarily induce further moults.

Wagner (1888) has described the histological changes of moult. I would simply add here that the moult in all the spiders observed by me follows the same plan: a horizontal split of the old skin along the sides of the abdomen and of the cephalothorax (here just above the legs and the jaws), so that the skin breaks into a dorsal and ventral piece. This is quite different from the process of moult in insects and crustaceans.

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EXPLANATION OF PLATES IV AND V.

All the drawings are freehand outline sketches, and as such do not claim to be accurate in all dimensional proportions, though the attitudes are true to nature and all are studies from life. The degree of magnification varies in the different figures.

PLATE IV, Fig. 1.—Lateral view of a female *Ocyale undata*, hanging in her web and holding her cocoon.

Fig. 2.—Copulation of *Theridium tepidariorum*, lateral view at the instant when the male seizes the female.

Fig. 3.—Copulation of *Pholcus phalangioides*, only the proximal portions of the legs shown.

Fig. 4.—Copulation of *Agalena nævia*, the female below and partially upon her side, the male's left palpus applied to the epigynum.

Fig. 5.—Copulation of *Acrosoma gracile*, the male with his left palpus applied to the epigynum; the male is drawn proportionately somewhat too large.

PLATE V, Fig. 6.—Copulation of *Dictyna volupis*, the left palpus of the male inserted; the third leg of the male and the posterior end of the abdomen of the female are supported by the web.

Fig. 7.—Copulation of *Xysticus stomachosus*.

Fig. 8.—Copulation of *Pardosa nigropalpis*, lateral view, the male with his left palpus inserted.

Fig. 9.—A female *Pardosa nigropalpis* holding her cocoon beneath her cephalothorax; this is the attitude when she finishes spinning the cover of the cocoon, and when she bites it open to free the young.

Fig. 10.—Copulation of *Lycosa stonei*, dorsal view, the male inserting his right palpus, the cephalothorax of the female hidden by the male.

FEBRUARY 3.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Fourteen persons present

Papers under the following titles were presented for publication:

"New Lithobii from California and Oregon," by Ralph V. Chamberlin.

"Descriptions of Several Fishes from Zanzibar Island, Two of which are New" by Henry W. Fowler.

The death of Anthony J. Antelo, a member, was announced.

FEBRUARY 10.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Sixteen persons present.

Papers under the following titles were presented for publication:

"A Revision of the Orthopterous Genus Homœogamia," by James A. G. Rehn.

"Mollusca of Western Kansas and Adjacent States, with a Revision of Paravitrea," by Henry A. Pilsbry.

"A Revision of the North American Ants of the Genus Leptothorax Mayr," by William Morton Wheeler.

FEBRUARY 17.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the chair.

Nine persons present.

A paper entitled "Notes on the Conrad Collection of Vicksburg Fossils, with Descriptions of New Species," by Thomas L. Casey, was presented for publication.

FEBRUARY 24.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Twenty-eight persons present.

Papers under the following titles were presented for publication:

"The Variations of Eutænia in the Pacific Sub-region," by Arthur Erwin Brown.

"A New Species of Nyctalemon," by Henry Skinner, M.D.

Miss Lucy W. Baird was elected a member.

The following were ordered to be printed:

NEW LITHOBII FROM CALIFORNIA AND OREGON.

BY RALPH V. CHAMBERLIN.

Since Dr. Anton Stuxberg published his *Lithobioidæ Americæ Borealis* in 1875, very little has been added to our knowledge of the Lithobii of the Pacific coast region. A study of somewhat extensive collections made at various points in California and Oregon during 1902 enables me now to present descriptions of ten species not previously recorded, as well as to identify with certainty various species described by earlier writers. In the key which follows I have included, in addition to the new forms, also such other related species as seemed proper for purposes of comparison:

Analytical Key to Species Considered.

A.—Coxal pores in several series (Bothropolys).
- a_1.—Angles of the 9th, 11th and 13th dorsal plates produced.
  - b_1.—Articles of antennæ 28–31; pairs of ocelli 30; coxal pores round or oval; length 15–18 mm., width 2.2 mm.; length of anal legs 6 mm., . *aztecus* Humb. et Sauss.
  - b_2.—Articles of antennæ 42–46; pairs of ocelli 16–21; coxal pores strongly transverse (adults); length 22–23 mm., width 3.3–3.4 mm.; length of anal legs 10.5 mm., *chumasanus* sp. nov.
- a_2.—Angles of none of the dorsal plates produced.
  - b_1.—Articles of antennæ 20; pairs of ocelli 7–9 in 2 series; prosternal teeth 6–6; spines of anal legs 1, 4, 3, 1–1, 4, 3, 2; length 18 mm., . . . *monticola* Stux.
  - b_2.—Articles of antennæ 23–27 (normally); pairs of ocelli 17–21 in 4 or 5 series; prosternal teeth 8–8 to 13–13; spines of anal legs 1, 3, 2, 1; length 20–24 mm., *sierravagus* sp. nov.

B.—Coxal pores in a single series (Lithobius).
- a_1.—Angles of the 9th, 11th and 13th dorsal plates produced.
  - b_1.—Articles of antennæ 26–28; prosternal teeth 2–2; posterior coxæ unarmed laterally; spines of penult legs 1, 3, 3, 1, of anal 1 3, 2, 1 . . . . *angelus* sp. nov.
  - b_2.—Articles of antennæ 39–44; prosternal teeth 4–4; posterior coxæ armed laterally; spines of penult legs 1, 3, 3, 2, of anal 1, 3, 3, 1, . . . *bellulus* sp. nov.
- a_2.—Angles of none of the dorsal plates produced.

b_1.—Posterior coxæ unarmed with spines; ocelli 6 in 2 series; porigerous area of coxæ deeply depressed, pores 3, 4, 4, 3; anal legs of ♂ conspicuously compressed sublaterally, without produced lobes; length 8 mm., *remex* sp. nov.

b_2.—Posterior coxæ armed laterally (porigerous area of last coxæ not deeply depressed).

c_1.—Last 3 pairs of coxæ laterally armed.

d_1.—Ocelli 8–12; spines of first legs 1, 2, 1, of penult 1, 3, 3, 0–1, 3, 3, 1, of anal 1, 3, 3, 0; length 7.5–9 mm., ... *eigenmanni* Boll.

d_2.—Ocelli 12–15; spines of first legs 2, 3, 2, of penult 1, 3, 3, 2, of anal 1, 3, 2, 0; length 11.5–13 mm., . . . *pitophilus* sp. nov.

c_2.—Last two pairs of coxæ laterally armed.

d_1.—Anal legs in ♂ not specially modified; claw of ♀ gonopods tripartite; coxal pores 2, 2, 3, 3–3, 3, 4, 3, very small; spines of first legs 1, 2, 1, of anal 1, 3, 3, 1; length 8–8.5 mm., *sastianus* sp. nov.

d_2.—Anal legs in ♂ not specially modified; claw of ♀ gonopods tripartite; coxal pores 3, 4, 4, 3–4, 5, 4, 4, large; spines of first legs 1, 3, 1, of anal 1, 3, 2, 0; length 9–10 mm., *mesechinus* sp. nov.

d_3.—Tibia of anal legs in ♂ produced above into a large peculiar lobe at distal end; (♀ unknown); coxal pores 2, 3, 3, 2, small; spines of first legs 1, 3, 2–2, 3, 2, of anal 1, 3, 2, 0; length 8.8 mm., ... *castellopes* sp. nov.

d_4.—Tibia of anal legs in ♂ produced into a conspicuous lobe at the superior-interior angle of proximal end; claw of ♀ gonopods tripartite; coxal pores 3, 4, 4, 3, moderately large; spines of first legs 1, 3, 2, of anal 1, 3, 2, 0–1, 3, 2, 1; length 10.5–11 mm., *clavigerens* sp. nov.

d_5.—Tibia of anal legs in ♂ excavated within near proximal joint, at which it and femur are produced inward into a conspicuous lobe; claw of ♀ gonopods tripartite; coxal pores 2, 2, 2, 2,–2, 3, 3, 3, small; spines of first legs 1, 2, 1,–2, 3, 2, of anal 1, 3, 2, 0; length 7.5–11 mm., ... *utahensis* Chamb.

d_6.—(♂ not known.) Claw of ♀ gonopods entire; coxal pores 2, 3, 3, 3; spines of first legs 1, 2, 1; of anal 1, 3, 2, 1; length 13 mm., *obesus* Stux.

1.2 mm.(♂)-1.4 mm. (♀); length of antennæ 2.2 mm.(♀)-2.8 mm. (♂); length of anal legs 2.2 mm.(♀)-2.8 mm. (♂).

Habitat.—Shasta Springs, Cal.

Etymology.—The Sastians or Shastans were a tribe of Indians formerly holding the country about Mt. Shasta, the locality in which the specimens were collected.

8. Lithobius mesechinus sp. nov.

Description.—Testaceous-brown, the legs and antennæ yellow, head and dorsal plates smooth or scarcely roughened, glabrous; ventral plates sparsely pilose, the posterior ones more densely so; legs very sparsely pilose; antennæ with the ultimate articles sparsely provided with stiff hairs, elsewhere very nearly glabrous. Head wider than long (7:6.25). Antennæ: articles 19–21, short, the ultimate shorter than the 2 preceding taken together. Ocelli on each side: 13, arranged in 3 series (1+5, 4, 3), pale. Prosternal teeth 2–2, pale, small. Spines of the first legs 1, 3, 1; spines of penult 1, 3, 3, 1–1, 3, 3, 2; anal legs with the claw unarmed, spines 1, 3, 2, 0; last 2 coxæ armed laterally toward dorsum and also dorsally; the median ventral spines of legs conspicuously longer than the others. Gonopods of ♀: claw tripartite, basal spines 2–2, acute.

Length of body 9–10 mm.; width of 8th dorsal plate 1.5 mm.; length of antennæ 2–3.5 mm.; length of anal legs 3.5 mm.

Habitat.—Meacham, Oreg.

Etymology.—Greek' μεσος, middle, and εχινος, a hedgehog, spiny object, etc., so named in reference to the long median ventral spines of the legs.

9. Lithobius castellopes sp. nov.

Description.—Brown, legs and antennæ paler, yellowish; head and dorsal plates smooth; head sparsely pilose with moderately long hairs; dorsal plates very sparsely pilose, more especially the posterior ones, particularly about the margins; ventral plates, prosternum and prehensorial feet sparsely pilose, the genital segment nearly glabrous below; legs sparsely pilose; antennæ subdensely clothed with rather long stiff hairs. Head nearly equal in length and width. Antennæ: articles 20, mostly short, the ultimate equal to or a little longer than the two preceding taken together. Ocelli on each side: 12, in 3 series (1+5, 4, 2). Prosternal teeth 2–2, small. Spines of the first legs 1, 3, 2–2, 3, 2; penult legs having the claw armed with 2 accessory spines or claws,

spines 1, 3, 3, 1; anal legs with the claw unarmed, spines 1, 3, 2, 0, in the ♂ much modified, enlarged, the tibia above at the distal end produced into a large knotty lobe, the lobe truncated posteriorly, sparsely pilose, bearing upon its posterior surface a spine which projects caudally; the last 2 pairs of coxæ armed laterally, the last 3 dorsally. Coxal pores very small, 2, 3, 3, 2

Length of body 8.8 mm.; width of 8th dorsal plate 1.3 mm.; length of antennæ 3 mm.; length of anal legs 3 mm.

Habitat.—Shasta Springs, Cal.

Etymology.—Latin *castellum*, a citadel or fortified place, and *pes*, foot, a name suggested by the appearance of the enlargement on the tibia of the ♂ anal legs.

10. Lithobius clavigerens sp. nov.

Description.—Color of body, antennæ and last pair of legs brown, other legs yellowish; head and dorsum smooth and glabrous, the head sparsely minutely punctate; ventral plates and the prosternum with prehensorial feet smooth, sparsely pilose, the last 2 together with the genital and anal segments subdensely pilose; antennæ pilose, the outer surface of the proximal articles subglabrous. Head sub-round, about equal in length and width, narrowed anteriorly. Antennæ: articles 20, the ultimate about equaling in length the 2 preceding taken together. Ocelli: 10–14, pale and distinct, in 3 series (1+5, 5, 3). Prosternal teeth 2–2, moderately small. Spines of the first legs 1, 3, 2, penult legs with 1 accessory claw, spines 1, 3, 3, 1; anal legs with the claw unarmed, spines 1, 3, 2, 0. Anal legs in ♀ scarcely more slender than in ♂; the exterior and interior superior margins of tibial and tarsal joints extended laterally, making the upper surface flat, the femur compressed in a different plane; the tibia densely punctate beneath, the tarsal joints less densely so; the first tarsal joint with a knob-like swelling at proximal end (absent in ♂); penult legs similarly modified to anal and to a scarcely smaller degree. In the ♂ the anal legs are also swollen along or a little below the superior margins, but the expanded portions are thicker and not so suggestive of flattening; tibia marked above for its entire length by a ridge-like swelling which at the proximal end is produced upward and inward into a conspicuous pilose lobe, tibia sparsely punctate beneath, the tarsal joints more densely so; in the penult legs the tibia is somewhat similarly modified to that of the anal legs, but the lobe at the proximal end is missing, not so strongly modified as in ♀. Coxal pores small and round, 3, 4, 4, 3. Gonopods of ♀: claw rather large, tripartite, lobes all acute,

the middle one much longest; basal spines 2–2, moderate, subequal, or the inner ones a little longer.

Length of body 10.5–11 mm.; width of 8th dorsal plate 1.4–1.5 mm.; length of antennæ and of anal legs each 4 mm.

Habitat.—Pacific Grove, Cal.

Etymology.—Latin *clavis*, a club, and *gerens*, participle of *gerere*, to bear; so named because the swelling on the dorsal surface of the tibia in the ♂ anal legs suggests a club with the large end placed proximally.

DESCRIPTIONS OF SEVERAL FISHES FROM ZANZIBAR ISLAND, TWO OF WHICH ARE NEW.

BY HENRY W. FOWLER.

A small collection of fishes has recently been forwarded to the Academy from Zanzibar Island, East Africa, by Sir Charles Eliot. At present all of the examples are contained in the collections of the Academy of Natural Sciences of Philadelphia.

PLATACIDÆ.

1. Platax vespertilio (Bloch).

1788. *Chætodon vespertilio* Bloch, Ichthyologie, II, pt. 6, p. 49, Plate 199, fig. 2; Je l'ai trouvé parmi les poissons qu'on m'a envoyés du Japon.
1866. *Platax vespertilio* Playfair, Fishes of Zanzibar, p. 64; Aden; Zanzibar [No descr.]

Head $2\frac{3}{4}$; depth equal to length; D. VI, 35; A. III, 26; P. 18; V. I, 5; scales, in the lateral line to the base of the caudal 66, between the origin of the soft dorsal and the upper curve of the lateral line about 24, and between the latter and the origin of the soft anal 38; width of head $1\frac{7}{8}$ in its length; snout $2\frac{1}{4}$; eye $3\frac{1}{2}$; maxillary $3\frac{1}{2}$; interorbital space $2\frac{3}{4}$; pectoral $1\frac{1}{2}$; least depth of caudal peduncle $2\frac{1}{3}$; ventral $1\frac{3}{4}$ in body.

Body very deep, greatly compressed, more or less trenchant above and below, and the greatest depth about midway in the length of body and between the origins of the soft dorsal and anal fins. Caudal peduncle short, deep and strongly compressed.

Head short, very deep, greatly compressed, and its greatest width at the preopercle considerably wider than any other portion of the body. The snout is rather long, steep, blunt and rounded above. Eye small, high in the head, and a little anterior. Mouth small, broad and nearly horizontal when closed. Maxillary small, obliquely vertical, and hardly reaching beyond the anterior nostril. Teeth small, sharp-pointed, and in rather narrow bands in the jaws. Vomer and palatines smooth. Mandible rather broad and slightly protruding, so that the anterior profile of the body forms a blunt angle at this point. Tongue not distinct from the floor of the mouth. Anterior nostrils circular, with the space between less than the space between the posterior pair,

and situated much nearer the front rim of the orbit than the tip of the snout. Interorbital space rather broad and convex.

Gill-opening oblique, and carried forward below the front rim of the pupil. Gill-rakers short, and in moderate number. Pseudobranchiæ absent. Gill-filaments very long and numerous.

Peritoneum silvery.

Scales small, finely ctenoid, and arranged in rather narrow vertical series. The greater basal portions of the vertical fins covered with small scales. Snout, interorbital space, occipital process, jaws and lower surface of the head naked, otherwise covered with small scales. No pectoral flap. Ventral connected at the base by two frena, the outer scaled, and the inner joining the innermost ray with the belly. Lateral line continuous, strongly arched anteriorly.

Dorsal spines graduated from the first, which is very short, to the last, which is many times its length. The anterior rays of the soft dorsal and anal are very elongate and produced, those of the former nearly as deep as the body. They become graduated posteriorly to the last which are very short. The anal spines are similar to those of the dorsal, only much shorter. Caudal small, and rather deep. Pectoral short. Ventral very long, the outer rays three times the length of the inner, or half the depth of the body.

Color in alcohol dark brown, the soft dorsal and anal blackish. Caudal blackish at base and sharply defined from the rest of the fin, which is pale straw color. Pectoral pale brown. Ventral blackish.

Length 3½ inches.

Two examples. The larger, which is described above, agrees with Bloch's figure perfectly in the broad vertical fins and the dark sharply defined color on the base of the caudal. The other has the dorsal, anal, and ventral very much more elongate, and the colors paler. These fins are blackish, and the outer edge of the ventral is whitish.

No traces are evident of the two vertical bands shown on the anterior part of the body, like those in Rüppell's figure of *Platax albipunctatus*.

BALISTIDÆ.

2. Balistapus aculeatus (Linnæus).

1758. [*Balistes*] *aculeatus* Linnæus, Syst. Nat., Ed. X, p. 328; India.

1866. *Balistes aculeatus* Günther, Fishes of Zanzibar, p. 134; Zanzibar. [No descr.]

1870. *Balistes aculeatus* Günther, Cat. Fish. Brit. Mus., VIII, p. 223; Isle of France; Island of Johanna (Coll. Dr. Kirk); Zanzibar (Coll. Lieut.-Col. Playfair); West Coast of Africa; Moluccas; Amboyna (Coll. M. Frank); China Seas; Pacific (Coll. M. Haslar); Feejee Islands; Micronesia (Coll. M. Wright); Seychelles (Coll. Prof. E. P. Wright); Mauritius.

1899. *Balistes aculeatus* Jatzow and Lenz, Abhand. Senck. Naturf. Gesel., XXI, p. 530; S. Juan de Nova; Zanzibar (Coll. Dr. Voeltzkow). [No descr.].

Head $2\frac{3}{5}$; depth $1\frac{1}{5}$; D. III–25; A. 21; scales about 42 to base of caudal; width of head 2 in its length; depth of head, measured vertically over posterior rim of orbit, greater than the length of the head by a little over half an eye-diameter; snout $1\frac{2}{5}$; eye $3\frac{2}{3}$; interorbital space $3\frac{2}{5}$; first dorsal spine $1\frac{9}{10}$; base of soft dorsal $1\frac{3}{7}$; base of anal $1\frac{2}{3}$; caudal 2; least depth of caudal peduncle $3\frac{4}{5}$; pectoral $2\frac{2}{3}$.

Body elongate, somewhat elliptical and strongly compressed. The greatest depth about the middle of its length, or in the region of the base of the ventral spine. Caudal peduncle compressed and rather thick.

Head long, angular, the upper profile more or less straight, at least in front, and the lower profile evenly convex. Snout long, convex above, very oblique, and the cheek compressed. Eye small, high, very posterior, and about two-fifths the length of the snout. Mouth small, and with thick fleshy lips. Jaws nearly equal, the teeth protruding. Teeth large, powerful, the edges sharp and notched. Nostrils small, very close together, lateral and in front of the eye above. Interorbital space, together with the space posterior to the eyes, convex.

Gill-opening small, about two-thirds the interorbital space.

Peritoneum black.

Scales all very rough, those on the head and abdomen all more or less in oblique rows, and those on the trunk in nearly vertical series. Tubercles on the back between the dorsal fins enlarged, much larger than the three horizontal series of spines on the side of the caudal peduncle. A number of rather long spines between the ventral spine and the origin of the anal fin. About five enlarged bones above the base of the pectoral behind the gill-opening.

Origin of the spinous dorsal about over the gill-opening, the first spine very large, robust and rough on the anterior surface, second spine much smaller and slender, and the third minute. The fin is depressable in a groove. Soft dorsal and anal opposite, and the rays all of nearly uniform height or about equal to the length of the eye. Caudal broad, rather deep, and the margin straight. Pectoral broad, rounded and short. Ventral spine rather long, freely movable and rough.

Color in alcohol faded more or less uniform brown. Side with a deep brown band running from the gill-opening to the anterior and posterior rays of the dorsal, leaving a pale area at the middle of the base of this fin. Below, and running obliquely backward to the base of the anal, are first one broad dark band, and then three narrower. The dark band from the eye down to the base of the pectoral is distinct,

and the dark interorbital space with four narrow connecting lines is also very distinct. Three series of tubercles on the side of the caudal peduncle blackish. Membrane of the spinous dorsal blackish, the other fins plain pale brown. Very indistinct traces of the pale longitudinal lines on the soft dorsal and anal are still evident.

Length $2\frac{3}{16}$ inches.

One example.

TETRAODONTIDÆ.

3. Tetraodon aerostaticus (Jenyns).

1842. *Tetrodon aerostaticus* Jenyns, Zool. Voy. Beagle, Fish, pt. 4, p. 152. [Locality unknown.]

1866. *Tetrodon lineatus* Günther, Fishes of Zanzibar, p. 131; Zanzibar. [Not of Linnæus.]

1870. *Tetrodon stellatus* Günther, Cat. Fish. Brit. Mus., VIII, p. 294; Port Natal (Coll. M. Ayres); Zanzibar (Coll. Lieut.-Col. Playfair); Amboyna (Colls. M. Frank, Dr. Bleeker. Type of *Tetrodon astrotaenia* Bleeker); Japan; Feejee Islands. [Part, not var. α and β.]

Head $2\frac{1}{3}$; depth (not inflated) about $2\frac{2}{3}$; D. 10; A. 10; P. 19; width of head greater than its length by nearly an eye-diameter; snout 2 in the head; eye about 6; interorbital space $1\frac{4}{5}$; length of dorsal $2\frac{1}{3}$; anal $2\frac{2}{3}$; caudal 2; pectoral 3; width of base of pectoral about $3\frac{4}{5}$; least depth of caudal peduncle 4.

Body short, broad, and the belly capable of being greatly inflated, the greatest width about the bases of the pectorals. Caudal peduncle not very long, compressed.

Head large, very broad, rounded or strongly conic above. Side of the head more or less constricted, and the cheek not very convex. Snout rather long, rather obtuse, and its upper profile a little concave. Eye rather small, about two-fifths the length of the snout, high, and about midway in the length of the head. Mouth rather small, broad, its width nearly twice the eye-diameter. Lips broad, fleshy, covering the greater portions of the teeth. Teeth large, very powerful, the cutting edges concave and the suture without deep groove or ridges on each side. Bifid tentacle conspicuous, about the last third of the space between the upper lip and the front margin of the eye. Interorbital space very broad, nearly flattened in front, and becoming gradually slightly convex posteriorly. The internasal space is about one-half as wide as the interorbital.

Gill-opening nearly as wide as the base of the pectoral, or about equal to the internasal space.

Peritoneum silvery.

With the exception of the lips, bases of the fins, and caudal peduncle,

the body is covered with rather large conspicuous spines, which are very rough to the touch. Those on the upper surface are short and sharp, and those on the belly elongate and somewhat clavate.

Origin of the dorsal nearer the tip of the caudal than the posterior margin of the eye, and the fourth ray the longest. Anal entirely behind the dorsal, the fifth and sixth rays the longest, and, like the other fins, rounded. Caudal elongate, deep, and the margin rounded. Pectoral broad, the upper rays the longest, and situated directly behind the gill-opening.

Color in alcohol dark brown, especially on the back, the belly hardly paler. The back, upper portion of the head, caudal peduncle, and caudal fin, marked with numerous small round blackish spots. The dorsal, anal and pectorals plain brown without markings. The flanks are marked with about six oblique blackish bands, the first few broadest, and none of them extending on the middle of the belly. Vent blackish. Bases of the pectoral and anal with several dark spots.

Length $4\frac{1}{16}$ inches.

One example.

4. Tetraodon immaculatus (Schneider).

1801. [*Tetrodon*] *Immaculatus* Schneider, Syst. Ichth., p. 507. [After Lacépède.][1]

1866. *Tetrodon immaculatus* Günther, Fishes of Zanzibar, p. 132; Aden; Zanzibar.

1870. [*Tetrodon immaculatus*] var. *immaculata* Günther, Cat. Fish. Brit. Mus., VIII, pp. 291, 292; Port Natal (Coll. M. Ayres); Zanzibar (Coll. Lieut.-Col. Playfair); Mauritius (Coll. M. Cuming); Penang (Coll. Dr. Cantor); East-Indian archipelago; New Caledonia (Coll. M. Cuming); Australia. (Colls. M. Gould, Earl of Derby.)

Head $2\frac{2}{3}$; depth (not inflated) about $2\frac{2}{3}$; D. 8; A. 9; P. 17; width of head $1\frac{1}{4}$ in its length; snout $2\frac{1}{4}$ in the head; eye $6\frac{1}{2}$; interorbital space 2; length of dorsal $2\frac{1}{8}$; anal $2\frac{1}{4}$; caudal $1\frac{1}{5}$; pectoral $2\frac{3}{8}$; least depth of caudal peduncle 3.

Body rather short, compressed, moderately broad, and the belly capable of great inflation, the greatest width about the bases of the pectorals. Caudal peduncle rather short, deep and compressed.

Head moderately large, rather broad, rounded and little depressed above. Side of the head not very convex. Snout long, blunt, and with the upper profile straight. Eye small, a little nearer the gill-opening than the tip of the snout. Mouth small, terminal, oblique, with the mandible protruding, and its width about equal to one and one-half eye-diameters. Lips broad, fleshy, and almost entirely cov-

[1] Based on "*Le tetrodon sans-tache*" Lacépède, Hist. Nat. Poiss., I, 1798, pp. 475, 486, plate 24, fig. 1. [From Commerson; no locality.]

ering the teeth. Teeth large, very powerful, the cutting edges of the mandibulars more concave than those above, and the suture with a pronounced groove but no ridge on either side. Bifid tentacles large, very conspicuous, and placed about the last third of the space between the upper lip and the front margin of the eye. Interorbital space broad and slightly convex.

Gill-opening equal to the internasal space or not quite as wide as the base of the pectoral.

Peritoneum silvery.

Lips, eyelids, margin of gill-opening, bases of the fins and the caudal peduncle naked, the other portions covered with rather large sharp spines, those on the belly longest and more or less slightly clavate.

Origin of the dorsal fin is much nearer the posterior margin of the eye than the tip of the caudal fin, and the fifth ray is the highest. The anal is similar to the dorsal, entirely posterior, and with the sixth ray the longest. Caudal long, rather broad, and with the margin slightly rounded. Pectoral broad, the upper rays the longest, and the fin rather short. All the fins have rounded edges.

Color in alcohol dark brown, the belly paler, and everywhere more or less uniform. Dorsal, anal and pectoral uniform pale brown. Caudal dark brown, with the margin all around broadly bordered with blackish brown. Each prick or spine is pale or whitish. The lips and bases of the fins are very dark brown.

Length $3\frac{3}{8}$ inches.

One example.

SCORPÆNIDÆ.

5. Pterois lunulata Schlegel. Plate VI.

1843. *Pterois lunulata* Schlegel, Fauna Japonica, Poiss., p. 45, Plate 19; la baie de Nagasaki, principalement à l'embouchure des fleuves.

1866. *Pterois lunulata* Playfair, Fishes of Zanzibar, p. 48; Aden; Zanzibar. [No descr.]

Head $2\frac{9}{10}$; depth $3\frac{1}{8}$; D. XIII, I, 10; A. III, 7; P. 14; V. I, 5; scales 64 in a lateral series to the base of the caudal, and about 4 more on the basal portion of the latter; about 11 scales between the second dorsal spine and the lateral line; 16 scales between the lateral line and the origin of the anal, and about 25? between the former and the middle of the belly; width of head $1\frac{1}{2}$ in its length; depth of head $1\frac{1}{6}$; snout $2\frac{3}{4}$ in head; eye $4\frac{1}{6}$; maxillary 2; mandible $1\frac{2}{3}$; interorbital space $4\frac{3}{4}$; least depth of caudal peduncle $3\frac{1}{2}$; first dorsal spine $1\frac{2}{3}$; second 3 in body; hird $2\frac{3}{5}$; fourth $2\frac{1}{3}$; fifth $2\frac{1}{3}$; sixth $2\frac{1}{6}$; thirteenth $2\frac{2}{3}$ in the head;

third dorsal ray, $1\frac{1}{5}$; third anal spine $1\frac{5}{6}$; third anal ray 1; caudal $2\frac{2}{3}$ in body; ventral spine $1\frac{2}{3}$ in head; ventral fin $2\frac{1}{4}$ in body.

Body elongate, compressed, the greatest depth about the anterior dorsal spines.

Head compressed, rather deep and somewhat bluntly pointed. Its greatest width is a little greater than the greatest width of the body, which is at the bases of the pectorals. Snout rather long, blunt, and with a marked prominence above. Preorbital space broad. Eye moderate, high, and a little anterior in the head. Mouth large, oblique, and the maxillary reaching back till below the front rim of the pupil. Distal expanded extremity of the maxillary broad, equal to three-quarters the eye-diameter, and inclined below ventrally. Jaws and vomer with bands of very fine teeth. Tongue thick posteriorly, and in a rather long, thin, compressed point, which is free in front. Lips fleshy, the lower on the side of each ramus of the mandible very thick. The lower jaw large, protruding when the mouth is closed, and with a small protuberance at the symphysis. The interorbital space is rather narrow, deeply concave, and with a rather shallow median groove. Nostrils well separated, circular, the rims a little elevated, and the anterior with a small thin flap.

No nasal spines. Preocular spines very blunt, and more or less concealed in the skin. Postocular spine very broad, obtuse. Coronal and tympanic spines developed as low obscure ridges, and with a similar median spine between the former. Parietal spines large and broad. Nuchal spines small. Margin of the preorbital with two blunt, obtuse spines. Cheek with a bony ridge, furnished with a blunt spine at the preopercle. Margin of the preopercle with three obtuse spines. Mastoid and suprascapula each with a long spine. Opercle with a broad spine posteriorly.

Gill-opening large, continued forward below the posterior nostril. Rakers short, thick. Gill-filaments much longer, though also rather short. Pseudobranchiæ. Isthmus broad, with a broad groove, and the branchiostegal membranes connected for a short distance.

Scales small, cycloid, and present on the greater part of the head, except the jaws, snout and maxillary. A pair of short narrow cutaneous flaps at the tip of the snout, and the two large obtuse spines along the preorbital margin each concealed in a rather long flap. Three short dermal flaps along the lower margin of the preoperculum. No flaps at bases of the paired fins. Scales rather large on the side and posterior portion of the trunk. Bases of the caudal, pectoral and ventral with small scales, the other fins without scales. Lateral line

concurrent with the back, slightly inclined, and running out on the basal scales of the caudal. The tubes elongate.

Peritoneum pale or whitish.

Spines of the dorsal very high, graduated to the fourth, after which, to the eleventh, they are more or less equal. The last two are much shorter than the first. The membranes are only present on the basal portion of the fin, though higher below the posterior longer spines. Soft dorsal nearly twice as high as its base. Anal inserted nearly midway between the origin of the ventral and the base of the caudal. The anal spines are graduated to the third, which is the longest, and the membrane joining it with the first anal ray is complete. Soft anal long, inserted about under the origin of the soft dorsal, and twice as high as the length of its base. Caudal very long, rounded and the middle rays the longest. Pectoral very long, the upper rays reaching beyond the caudal, and all united by a membrane, which is rather broad basally though not extending beyond half the length of the longest rays. Ventral inserted a trifle in advance of the pectoral, the spine slender, and the fin reaching a little beyond the origin of the soft anal.

Color in alcohol pale brown, the head and trunk marked with a series of deep brown alternating narrow and broad vertical stripes, or bands. On the front part of the head these radiate from the eye, and those on the trunk extend up on the basal portions of the vertical fins, though soon fading away on the soft dorsal and anal. Stripes on the interorbital space narrow and longitudinal. Region above the base of the pectoral more or less blackish. Spines of the dorsal marked with broad blackish cross-bands. Soft dorsal, anal and caudal, with the rays marked with about six series of narrow dark brown or blackish cross-bars. Pectoral more or less blackish, the rays with broad whitish cross-bands, and reflected on the membranes at the base of the fin as indistinct pale blotches. The basal portion of the fin is pale brown, like the general body color, marked with deep brown bands running into the black membranes. Inside of the base of the pectoral blackish, with several paler bands, and a few white spots. Ventral blackish, with several series of small white spots.

Length $4\frac{5}{16}$ inches.

One example.

I follow Colonel Playfair in recording this species from Zanzibar. Schlegel's figure is very crude and might easily be mistaken for some other fish. Bleeker's figure is scarcely an improvement.

CEPHALACANTHIDÆ.

6. Cephalacanthus spinarella (Linnæus).

1758. [*Gasterosteus*] *Spinarella* Linnæus, Syst. Nat., Ed. X, p. 297; India.[2]
1866. *Dactylopterus orientalis* Playfair, Fishes of Zanzibar, p. 49; Aden; Zanzibar. [No descr.]
1893. *Dactylopterus orientalis* Pfeffer, Jahrb. Hamburg. Wiss. Anst., X. p. 12; Sansibar. [No descr.]

Head $3\frac{3}{4}$; depth 5; D. I–I–6–8; A. 6; P. 31; V. 5; scales, in a lateral series to the base of the caudal 50, and about 28 in a transverse series between the spinous dorsal and the middle of the belly; width of head $1\frac{1}{10}$ in its length; depth of head $1\frac{1}{2}$; snout $2\frac{3}{4}$; eye $2\frac{3}{4}$; maxillary $2\frac{3}{4}$; width of mouth $2\frac{2}{5}$; mandible $2\frac{2}{3}$; interorbital space $1\frac{9}{10}$; least depth of caudal peduncle $4\frac{1}{2}$; first dorsal spine $1\frac{1}{3}$; second $3\frac{1}{2}$; third $1\frac{3}{5}$; first dorsal ray $1\frac{1}{6}$; base of soft dorsal $1\frac{1}{2}$; base of anal $2\frac{3}{5}$; ventral $1\frac{1}{8}$.

Body elongate, depressed, the greatest depth about the base of the ventral. Caudal peduncle broad, depressed, about as wide as deep at its least depth.

Head large, broad, and the greatest width a little less than the greatest width of the body, which is at the bases of the pectorals. The upper profile forms obtusely above the front of the eye. Snout broad, blunt, rounded and projecting beyond the jaws. Eye large, nearer the tip of the snout than the gill-opening in profile, and with the marginal bones large and strong. Mouth inferior, much broader than long, and the maxillary hardly reaching below the middle of the orbit. Lips rather thick. Teeth fine, minute, and in bands in the jaws, none on the vomer or palatines. Tongue broad, short, angular, and not free from the floor of the mouth. Upper jaw produced beyond the mandible. Nostrils close together, with slightly raised rims, and the space between the anterior pair, which are closer together than the others, about two-fifths the interorbital space. Interorbital space very broad and deeply concave. Surface of the head almost entirely rugose, and the opercle and preopercle striate. Suborbital spine short, reaching below the upper margin of the preopercle, and forming a deeply dented margin running up to the lower posterior rim of the orbit. Preopercle ending in a very long dagger-like spine reaching opposite the fourth dorsal spine. Nuchal crests strongly ridged, with several denticulations, and reaching posteriorly below the tip of the preopercular spine.

Gill-opening rather small, lateral, its length about equal to the eye.

Peritoneum pale.

Scales strongly keeled, bony, and arranged in longitudinal series.

[2] Based on [*Pungitius*] *pusillus* Linnæus, *Mus. Adolph. Fred.*, 1754, p. 74, Plate 32, fig. 5 (three figures). [No locality.]

On the anterior portion of the body the series are close together, broadening out behind so that some above run up toward the middle of the back, and some of the lower run toward the lower median line. On the chest the scales are small and only slightly keeled. On each lower side of the caudal peduncle are a series of three enlarged compressed scales. The keels on the scales, in this region, are also large. Base of the caudal above and below with elongate compressed scales. Bases of the other fins without any scales.

First dorsal spine situated at the angle of the nuchal shield, a little before the gill-opening. Second dorsal spine short, nearer the third than the first. Third dorsal spine a little nearer the posterior margin of the orbit than the origin of the soft dorsal, and with the remaining spines all graduated to the last which are very short. Origin of the soft dorsal a little nearer the base of the first dorsal spine than the base of the caudal, and the anterior rays the highest. Anal inserted a little nearer the base of the caudal than the base of the ventrals, and the second ray about equal to the length of the caudal peduncle. Caudal small, lunate. Pectoral long, reaching beyond the base of the caudal. Ventrals close together, elongate, and reaching the anus, which is a little distance in advance of the origin of the anal.

Color in alcohol brown, a little darker above. Back with four broad obscure saddle-like bands. A dark brown band connecting the eyes and continued down below on each cheek. First dorsal spine with a blackish membrane. Other dorsal fins dusky with obscure dark brown cross-bars. Anal and ventral pale brown. Caudal barred with brown. Pectoral blackish with obscure gray and dusky blotches.

Length 4 inches.

One example.

BLENNIIDÆ.[3]

7. Aspidontus tractus sp. nov. Plate VII

Head $3\frac{3}{4}$; depth 5; D. XI, 28; A. 26; P. 14; V. 3; width of head $2\frac{1}{10}$ in its length; depth of head $1\frac{9}{10}$; snout $3\frac{1}{5}$; eye $4\frac{1}{2}$; width of mouth $4\frac{2}{3}$;

[3] GRAVICEPS, gen. nov.

The genus *Aspidontus* as here understood includes but two species, the one described above and *A. tæniatus* Quoy and Gaimard. The species included by Jordan and Snyder in their review of the Blennioid fishes of Japan (*Proc. U. S. Nat. Mus.*, XXV, 1902, pp. 453 to 458) appear to form a separate genus. They are all easily distinguished by the short blunt snout, which is not produced or pig-like.

Type *Petroscirtes elegans* Steindachner.

(*Graviceps*, heavy-head.)

interorbital space 4; depth of caudal peduncle $2\frac{1}{2}$; width of base of pectoral 4; length of pectoral $2\frac{1}{2}$; ventral $2\frac{1}{4}$.

Body moderately elongate, strongly compressed, and the greatest depth about the middle of the belly. The greatest width less than that of the head, and at the bases of the pectorals. Caudal peduncle not defined, as the posterior rays of the dorsal and anal are more or less connected with the caudal, deep and strongly compressed.

Head large, attenuate, conic, and its greatest width at the opercles. The upper and lower profiles nearly evenly straight, so that the tip of the snout is midway in the height of the head. Snout long, conic, produced, and not very broad. Eye rather small, a little superior, and well anterior. Mouth inferior, some little distance from the tip of the snout, very broad, transverse, and the gape not reaching the front margin of the orbit. Lips thin, that on the mandible rather broad. Teeth compressed, uniserial in the jaws, and attenuately rounded at their extremities. A large curved canine on each side of the mandible, and not separated from the others. No teeth on the vomer or palatines. Nostrils well separated, the anterior about the last fourth of the space between the tip of the snout and the posterior, which is over the front rim of the orbit. The internasal space is about two-thirds the diameter of the eye. Interorbital space rather broad, convex like the rest of the upper surface of the head. The suborbital bones are somewhat rugose and covered with a thin membrane. The sides of the head posterior and superior to the eyes are similar. The lower surface of the head is broad, convex and rounded like the top or upper surface.

Gill-opening small, in front of the upper base of the pectoral and about equal to the eye.

Peritoneum whitish.

Anus near the origin of the anal fin.

Body naked, the skin smooth. Head with a number of small mucous pores. Paired fins without flaps or sheaths.

Origin of the dorsal well forward, only just a trifle behind the eye. The spines are very flexible, hardly to be distinguished from the rays, which are not branched. The bases of the former are a little further apart than those of the rays. The first few spines are graduated, after which the whole dorsal fin assumes a more or less uniform height to the last rays, which decrease and are united with the caudal peduncle by a low membrane reaching to the base of the caudal. The anal is similar to the dorsals, except that the margin of the fin is incised between the rays. The anal spine is scarcely to be distinguished from

the rays. The origin of the anal is much nearer the base of the caudal than the tip of the snout. Caudal broad, somewhat truncate, and the lower rays the longest. Pectoral broad, also rather truncate. Ventrals close together, inserted about opposite the last third of the space between the posterior margin of the eye and the margin of the gill-opening.

Color in alcohol more or less dark slaty-blue, giving place to dark brown. The posterior half of the trunk shading into dusky. A black band, at first about half or a little less than the eye-diameter, running from the snout through the eye and back along the upper part of the side out on the caudal till near the tips of the lower median rays, and then curving down or bent back a trifle. From above the origin of the anal this band becomes much broader, occupying most of the upper portion till about as broad as the interorbital space. Belly and lower surface rather pale. A short dark brown oblique streak before the base of the pectoral. Margins of the dorsal, anal and caudal whitish, that of the latter very broad, especially at the corners. On the former two fins there is a narrow submarginal blackish band, fading below toward the basal portions of these fins into the bluish body color. Pectoral and ventral pale brown.

Length 3½ inches.

Type No. 24,207, Acad. Nat. Sci. Phila. Zanzibar. Coll. Sir Charles Eliot.

The only example I have seen is described above. It is closely related to *Aspidontus taeniatus* Quoy and Gaimard. It differs, however, in the short dark streak in front of the base of the pectoral. Their figure is very rough, and shows the outer portions of the upper and lower caudal rays bluish.[4]

Dr. Günther's figure of *Petroscirtes tæniatus*,[5] if at all accurate, is certainly distinct.

(*Tractus*, a streak.)

ANTENNARIIDÆ.

8. Antennarius argus sp. nov. Plate VIII.

Head (measured to axil of pectoral) 2⅗; depth 1; D. I–I–I–12; A. 7; P. 10; V. 5; width of head (measured to axil of pectoral) 1⅓ in its length; snout 4½ in head; eye about 8; maxillary 2; mandible 2; width of mouth 1⅗; interorbital space 3; bait 2⅕; second spine 3⅕;

[4] *Voyage de l'Astrolabe*, Zool., 1834, p. 719, Plate 19, fig. 4; l'île de Guam, devant la ville d'Agagna.

[5] (Fische der Südsee) *Journ. Mus. Godef.*, XI. 1876, p. 195, Plate 114, fig. A; Freundschafts-, Paumotu- und Fidschi-Inseln.

third spine $1\frac{5}{6}$; fourth dorsal ray $1\frac{7}{8}$; base of anal $2\frac{1}{6}$; fourth anal ray $2\frac{1}{4}$; caudal $1\frac{1}{2}$; least depth of caudal peduncle $3\frac{1}{3}$; base of pectoral $2\frac{1}{2}$; base of ventral $3\frac{1}{2}$.

Body deep, compressed, and the greatest depth about midway between the base of the first dorsal spine and the first dorsal ray. The back is elevated and the belly round and swollen. Caudal peduncle compressed, rather small.

Head very large, deep, with a steep declivous profile. The lower sides of the head about the greatest depth of the body, also its greatest width. Snout very short, steep, rough and broad. Eye small, very high and anterior. Mouth very large, nearly vertical, and the lower posterior margin of the maxillary hardly reaching below the front margin of the eye. Mandible very broad and with a slight knob at the symphysis. Lips rather thick. Teeth minute, and in rather broad bands in the jaws. Vomer and palatines with bands of minute teeth. Tongue large, thick, occupying the whole of the floor of the mouth, and with a patch of large short coarse teeth medianly. Nostrils small, obscure, close together, and near the edge of the snout. Interorbital space broad, and rough. Top of the head below the third dorsal spine swollen.

Gill-opening a small pore at the lower base of the pectoral, and nearly in the middle of the length of the entire fish.

Peritoneum silvery.

Anus near the front of the anal fin and with a small genital papilla posterior.

Body very finely roughened everywhere, except on the lower surfaces of the pectorals and ventrals. Tubercles on the head, and in the lateral line anteriorly, not very conspicuous.

Bait with a large tuft of filaments at its extremity. Second dorsal spine closely following, and united behind with a broad roughened membrane with the interorbital space. Third dorsal spine clavate beginning at the tip of the depressed second spine or a little behind the eye, and also united to the occiput with a broad rough membrane. Soft dorsal rather high and long, and its margin straight. Anal small, very posterior, and extending back rather far on the caudal peduncle. Caudal large, broad and the upper rays the longest. All of the vertical fins rounded. Pectoral large, and the tips of the rays projecting a little beyond the membranes. Ventral similar to pectoral.

Color in alcohol pale or dusky gray-brown, more or less uniform, and marked everywhere with small round black ocelli, many scarcely larger than the pupil of the eye. The lower surfaces of the pectoral

and ventral are blackish without distinct spots. On the back and head many of the ocelli become very small. The outer portions of the paired fins are also darker than the other parts. Along the upper portion of the soft dorsal are four large blackish ocelli arranged at equal distances, and posteriorly on the base of the fin a much larger one. Anal similar but the basal ocellus at the fifth and sixth rays. There are also several enlarged ocelli on the sides of the body and caudal fin.

Length $3\frac{7}{16}$ inches.

Type No. 24,208, Acad. Nat. Sci. Phila. Zanzibar. Coll. Sir Charles Eliot.

One example, described above. It resembles *Antennarius phymatodes* Bleeker somewhat in color, but is apparently more closely related to *Antennarius polyophthalmus* Bleeker, from which it is distinguished by the very numerous ocelli.

Antennarius nigromaculatus Playfair is said to have a large black patch extending over the whole of the abdominal region.

(*Argus*, hundred-eyed, on account of the very numerous ocelli.)

9. Antennarius tuberosus Cuvier.

1817. *Chironectes tuberosus* Cuvier, Mém. Mus. Hist. Nat. Paris, III, p. 432; l'Isle de France. (Coll. M. Mathieu.)

Head (measured to axil of pectoral) $2\frac{1}{2}$; depth 2; D. I–I–I–11; A. 7; P. 9; V. 5; width of head (measured at opercle) about $1\frac{1}{5}$ in its length; snout 4 in head; eye about 6; maxillary $1\frac{7}{8}$; width of mouth $1\frac{7}{8}$; interorbital space $3\frac{1}{2}$; bait $4\frac{2}{3}$; second spine $4\frac{1}{2}$; third spine $2\frac{2}{3}$; eighth dorsal ray 2; base of anal $1\frac{1}{3}$; fourth anal ray 2; length of caudal $1\frac{1}{3}$; least depth of caudal peduncle $2\frac{1}{2}$; base of pectoral $2\frac{2}{3}$; base of ventral $3\frac{2}{3}$.

Body elongate, compressed, and the greatest depth about the origin of the soft dorsal. The back is elevated, especially between the third dorsal spine and the origin of the soft dorsal, sloping down gradually behind to the caudal peduncle. The abdomen is very large, rounded, or swollen. Caudal peduncle small, and but little free.

Head moderate, very deep, and with a steep round anterior profile. Side of the head more or less swollen in appearance, but with the greatest width of the body at the base of the pectoral in front. Snout very short, blunt, broad, and a little inclined. Eye small, very high and anterior. Mouth large, inclined forward so that the chin is produced. Maxillary concealed below. Mandible very broad and with a small symphyseal knob. Lips thick. Teeth small and in rather broad bands in the jaws. Vomer and palatines with bands of fine teeth. Tongue large, free around the edges so that it is very thick,

occupying the whole of the floor of the mouth, and with a patch of rather large teeth medianly. Nostrils small, close together and a little nearer the edge of the mouth than the front margin of the eye. Interorbital space moderate, elevated and rough. Top of the head below the third dorsal spine not very much swollen.

Gill-opening a small pore just below the base of the pectoral, and nearer the edge of the chin in front than the base of the caudal.

Peritoneum grayish-brown.

Anus conspicuous, in front of the origin of the anal.

Body very finely roughened everywhere, except on the extremities and lower surface of the pectoral and ventral rays. Tubercles on the head and anterior portion of the lateral line obscure and inconspicuous.

Bait short, with a small tuft of filaments at its extremity. Second dorsal spine closely following, about opposite the front rim of the orbit, free, and without membrane behind. Third dorsal spine large, thick, not very high, and joined to the occiput by a narrow membrane. Soft dorsal long, beginning a little behind the base of the pectoral above, and with the upper margin only slightly incised between the rays. Anal posterior, beginning a little nearer the tip of the caudal than the origin of the ventral, rounded, and the edge more or less similar to that of the soft dorsal. Caudal rounded, somewhat expanded, and the median rays the longest. Pectoral low, and the rays free for a good portion of their extremities. Ventrals situated below the third dorsal spine and the ends of the rays also free for a good distance.

Color in alcohol dark gray-brown, the margins of all the fins rather broadly whitish. Side and head more or less obscurely marbled with darker brown. The outer submarginal portions of all the fins blackish, variegated with paler or brownish. Base of the caudal pale brown.

Length $1\frac{1}{8}$ inches.

One example.

The name *bigibbus*[6] cannot date from the original edition of Lacépède, as it was not used as a binomial. The next name apparently available is that of Cuvier.

FAUNAL WORKS.

1865. R. L. PLAYFAIR and A. C. L. G. GÜNTHER. *The Fishes of Zanzibar*. London. Pp. 153. Plates 21. (Acanthopterygii by Lieut-Col. Playfair and Pharyngognathi, etc., by Dr. Günther.)

[6] *Lophie double-bosse* Lacépede, *Hist. Nat. Poiss.*, I, 1798, pp. 302, 325. [No locality. From Commerson MSS. as "Antennarius bigibbus, nigro et griseo variegatus."]

1868. A. C. L. G. GÜNTHER. Additions to the Ichthyological Fauna of Zanzibar. *Ann. Mag. Nat. Hist. London*, (4) I, pp. 457–459, with fig.

W. PETERS. Chiloglanis Deckenii, und einige andere Süsswasser-fische aus Ostafrika. *Monats. Ak. Wiss. Berlin*, pp. 598–602, with plate.

1869. R. L. PLAYFAIR. Further Contributions to the Ichthyology of Zanzibar. *Proc. Zool. Soc. London*, pp. 239, 240. Addendum, p. 241, by Dr. Günther.

1873. A. C. L. G. GÜNTHER. Further Additions to the Ichthyological Fauna of Zanzibar. *Ann. Mag. Nat. Hist. London*, (4) XII, p. 182.

1889. GEORG PFEFFER. Übersicht der von Herrn Dr. Franz Stuhlmann in Ägypten, auf Sansibar und dem gegenüber liegenden Festlande gesammelten Reptilien, Amphibien, Fische, Mollusken und Krebse. *Jahrb. Hamburg. wiss. Anst.*, VI, Fische, pp. 13–23.

1893. ——— ———. Ostafrikanische Fische gesammelt von Herrn Dr. F. Stuhlmann im Jahre 1888 und 1889. *Jahrb. Hamburg. wiss. Anst.*, X, pp. 1–49, Plates I–III.

1899. R. JATZOW and H. LENZ. Fische von Ost-Afrika, Madagaskar und Aldabra. *Abhand. Senck. Naturf. Gesel.*, XXI, pp. 497–531, Plates 34–36.

A REVISION OF THE ORTHOPTEROUS GENUS HOMŒOGAMIA.

BY JAMES A. G. REHN.

The present study is based on an examination of forty-nine specimens of the genus *Homœogamia,* from the collections of the Academy of Natural Sciences of Philadelphia and the United States National Museum. The receipt of an interesting series of specimens from the southwestern United States prompted the author to study the genus in detail. The results are here set forth.

Probably the most striking thing observed on examination of the literature and the material at hand is the scarcity of females of the genus. This sex is positively known in but three of the six species, and the rather extensive series studied contained but one adult female specimen.

In the case of known sexes or larvæ unrepresented in the series examined, the original description has been translated and placed in the proper position.

Several forms, in two cases based originally on the larvæ, which have not been recognized since the original description, are included at the end of the paper. In these cases the descriptions have not been translated.

HOMŒOGAMIA Burmeister.

1838. *Homœogamia* Burmeister, Handb. der Entom., Bd. II, Abth. II, pt.1, p. 490.
1864. *Homeogamia* Saussure, Mém. l'Hist. Nat. Mexique, IV, p. 226.
1865. *Homœogamia* Brunner, Nouv. Syst. Blatt., p. 360.
1868. *Polyphaga* Walker (not of Brullé), Catal. Blatt. Brit. Mus., p. 13.
1869. *Homœogamia* Saussure, Mél. Orthopt., II, p. 102.
1870. *Homœogamia* Saussure, Miss. Scientif. Mexique, Orth., p. 108.
1871. *Homœogamia* Walker, Catal. Derm. Salt. Brit. Mus., V, Suppl. Catal. Blatt., p. 3.
1871. *Polyphaga* Walker (not of Brullé), Catal. Derm. Salt. Brit. Mus., V, Suppl. Catal. Blatt., p. 3.
1890. *Homœogamia* Bolivar, Ann. Soc. Ent. France (6), X, p. 137.
1893. *Homœogamia* Saussure, Revue Suisse de Zoologie, I, fasc. 2, p. 294.
1894. *Homœogamia* Saussure and Zehntner, Biol. Cent.-Amer., Orth., I, p. 105.
1900. *Homœogamia* Scudder, Proc. Davenport Acad. Nat. Sci., VIII, p. 11.
1900. *Homœogamia* Rehn, Trans. Amer. Ent. Soc., XXVII, p. 85.
1901. *Homœogamia* Rehn, Trans. Amer. Ent. Soc., XXVII, p. 220.
1902. *Homœogamia* Scudder and Cockerell, Proc. Davenport Acad. Sci., IX, p. 19.
1903. *Homœogamia* Rehn, Proc. Acad. Nat. Sciences Phila., LIV (1902), p. 717.

Type.—*Homœogamia mexicana* Burmeister.

Generic Characters. — Sexes dissimilar, but both with tegmina developed. Tarsi without arolia. Males with the pronotum semicircular, sub-fusiform or pentagonous in outline; tegmina elongate, at least two and a half times as long as the transverse diameter of the pronotum. Females with the pronotum broad, sub-fusiform in outline, the anterior margin more arcuate than the posterior;[1] tegmina comparatively short and not more than one and a half times as long as the broad scoop-like pronotum; wings minute. Median and posterior tibiæ with six or seven apical spurs. Supra-anal plate of the male produced and distinctly bilobate, or produced and broadly emarginate. Supra-anal plate of the female produced, broadly rounded, with a narrow median emargination.

History.—The genus *Homœogamia* was originally founded in 1838 by Burmeister as a subgenus of *Heterogamia* (=*Polyphaga* Brullé). It was based entirely on *H. mexicana*, and the distinguishing characters were distinctly geographical—*Heterogamia* s. s. belonging to the Old World, and *Homœogamia* to the New. In 1864, Saussure placed it as a subgenus of *Polyphaga*, and located it in the "Polyphagiens," a division of the "Nuditarses," *Latindia* being associated with it. The same author described a species, *H. brasiliana*, from Brazil, basing it on a nymph. Brunner, in 1865, in his historic *Système* considered the division that of a full genus, and placed it with *Heterogamia* in a new family—the Heterogamidæ. In 1868, in the *Catalogue of the Blattariæ* in the British Museum, Walker erected the family Polyphagidæ, in which *Homœogamia* was placed. Saussure, in the *Melanges*, published in 1869, placed *Homœogamia* with *Polyphaga* in the "Polyphagiens," which he considered a division of the "Blattaires Mutiques a Tarses nus." He here also described *H. sinensis*, a species from northern China, which, as later shown, he has since removed from the genus.[2] The same writer, in the *Mission Scientifique*, published in 1870, considers the "Polyphagiens" as a division of the "Nuditarses," and *Homœogamia* was here regarded as a subgenus of *Polyphaga*. In 1871 Walker described a species, *Polyphaga æqualis*, which is probably a representative of the genus *Homœogamia*, but it has not been

[1] This character also applies to the males of several species of the genus.

[2] In the work above mentioned Saussure recognized the peculiar position of this species as he says: "The presence of an arolium on the tarsi in this species places it near *Polyphaga* (*Heterogamia*); nevertheless the appearance, the woolly nature of the body, the width of the marginal field of the elytra, and the curvature of the discoidal nervures adds much to the analogy with *Homœogamia*. This species thus establishes a type between the two genera."

recognized since the original description. Bolivar, in 1890, described the larva of a species of the genus from Venezuela, but refrained from naming it, although he considered it new. Saussure, in 1893, published his *Revision de la Tribu des Hétérogamiens*, in which he placed *Homœogamia* with *Heterogamia* in a separate tribe, along with two new genera, *Dyscologamia* and *Anisogamia*, which contained species from the Oriental region, South Africa and Central Asia. In this paper he discusses at great length the relationship of *Homœogamia* and *Heterogamia*, the result of which is that *Homœogamia* is restricted to the forms occurring in the New World. After commenting on Brunner's method of separating the genera, he presents the case in a manner which should be quoted entire to be understood:

"Depuis que les espèces connues se sont multipliées, les limites entre les deux genres sont devenues moins évidentes. On a trouvé en effet dans le régions chaudes de l'ancien continent des espèces chez lesquelles les femelles sont ailées et qui sembleraient par conséquent devoir rentrer dans le genre *Homœogamia* bien que les mâles possèdent des pelottes entre les griffes. D'autre part, les mâles des *Heterogamia* n'ont pas tous les tarses terminés par une pelotte. Les caractères sur lesquels les deux genres semblaient reposer se trouvent ainsi en apparence infirmés. On pourrait, il est vrai, chercher à résoudre la difficulté en faisant passer dans le genre *Homœogamia* les espèces de l'ancien continent dont le femelles sont ailées, mais cet arrangement ne s'accorderait ni avec les caractères des mâles, ni avec les caractères fournis par les pièces anales des femelles. Cette réunion ne serait donc pas naturelle. Les deux genres primitifs (correspondant à la distribution géographique des espèces) sont au contraire nettement séparés et, si les espèces ailées (♀) de l'ancien continent ressemblent aux *Homœogamia*, cela tient seulement à ce qu'elles ont parcouru comme ces dernières la phase d'*imago* qui leur a donné des organes du vol: elles n'ont pas pour cela perdu leur caractère d'*Heterogamia*. Je n'hésite donc pas à considérer toutes les espèces de l'ancien continent comme étant des *Heterogamia*, et à restriendre le genre *Homœogamia* à celles du nouveau monde. Les deux group doivent seulement être caractérisés d'un manière un peu différente qu'il n'a été fait au début.

"Je distingue comme suit les deux genres oú plutôt les deux types propres à chacun des continents:

"1° *Homœogamia.*—♂♀ toujours dépourvus d'arolium entre les griffes.—♀♀. Le dernier segment ventral comprimé en forme de bec à son extrémité; ce bec limité à sa base par de profonds sillons et comme

fendu, mais en réalité seulement partagé par un pli rentrant, en général appréciable seulement sous la forme d'un sillon longitudinal. (Le segment rappelant par son apparence le dernier segment ventral des Périplanétiens.)

"2° *Heterogamia* (sensu latiore).—♂♂. Tarses en général munis d'un petit arolium.—♀♀. Le dernier segment ventral non comprimé en bec, mais plat, avec le milieu renflé en bosse arrondie non partagée. Le corps ailé comme chez les *Homœogamia*, ou aptère de forme ovale-orbiculaire ou ovoïde, cilié sur ses bords, au moins le long du pronotum."

In the same year (1893) that the above appeared, but evidently having priority of publication, Brunner described a species (*Hom. capucina*) from Burma, which possesses a female with well-developed tegmina. The genus is placed by the same author in the *Corydidæ*, to which the whole "Heterogamides" is added. In 1894, Saussure and Zehntner, in the *Biologia Centrali-America*, placed *Homœogamia* as a member of the subfamily *Corydinæ*. The inference drawn from some statements in this work is that it was prepared before the *Revision . . . des Hétérogamiens*, but did not appear until later.

The two Old World species mentioned above have both been eliminated from *Homœogamia*, *sinensis* being removed to *Polyphaga* by Dohra (*Stettin Ent. Zeit.*, XLIX, p. 132, 1888) and *capucina* placed in *Dyscologamia* by Saussure (*Revue Suisse Zool.*, I, fasc. 2, p. 301, 1893).

Remarks.—After a study of the available specimens, and an examination of the numerous statements made in the works mentioned in the preceding historical sketch, the conclusion is reached that *Homœogamia*, as defined by Saussure, in 1893, is a tenable genus, though closely allied to *Polyphaga* Brullé (*Heterogamia* Burm. et auct.).

The two South American species, which are known only from the nymphs, have not been identified since the original descriptions, and as no material in this genus from that region is available, nothing critical has been done with them. The original descriptions of these species have been placed at the end of the article with the diagnosis of *Polyphaga æqualis* Walker, which probably was based on some member of this genus.

Key to the subgenera (based on the males).

A.—Supra-anal plate of male bilobate; median and posterior tibiæ with six apical spurs; vertex rounded.

B.—Marginal field of tegmina broad; tarsi comparatively robust, metatarsi of median limbs about half as long as the tibiæ, *Homœogamia* s. s.

BB.—Marginal field of tegmina narrow; tarsi very slender and elongate; metatarsi of median limbs about as long as the tibiæ, ... *Arenivaga* n. subg.

AA.—Supra-anal plate of male very broadly emarginate apically; median and posterior tibiæ with seven apical spines; vertex with a distinct angular transverse ridge, *Eremoblatta* n. subg.

Key to the species (based on the males).

A.—Supra-anal plate of male bilobate.
B.—Marginal field of tegmina broad.
c.—Elytra tessellate, never tuberculate; veins in the distal portion of the discoidal field longitudinal, *mexicana* Burmeister.
cc.[3]—Elytra sparsely tuberculate at base; veins in the distal portion of the discoidal field arcuate, *azteca* Saussure.
BB.—Marginal field of tegmina narrow.
c.—Interspace between the eyes narrower than that between the ocelli.
d.—Size rather large (length including tegmina 23–29 mm.), ... *bolliana* Saussure.
dd.—Size small (length including tegmina 19–21.5 mm.), *erratica* n. sp.
cc.—Interspace between the eyes not narrower than that between the ocelli, ... *apacha* Saussure.
AA.—Supra-anal plate of male very broadly emarginate, *subdiaphana* Scudder.

Subgenus HOMŒOGAMIA sen. strict.

Subgeneric Characters.—♂. Size rather large; form graceful. Tegmina elongate with the lateral margins sub-parallel; marginal field broad, equal to one-third of the sub-basal width of the tegmina; veins in the distal portion of the discoidal field arcuate transverse. Tarsi comparatively robust; metatarsi of median limbs about half as long as the tibiæ.

♀. Size large; form obese. Tegmina broad, but slightly exceeding the abdomen in length, the lateral margins parallel in the distal half. Metatarsi of median limbs not half as long as the tibiæ.

Homœogamia mexicana Burmeister.

1838. *Heterogamia (Homœogamia) mexicana* Burmeister, Handb. d. Entom., Bd. II, Abth. II, pt. 1, p. 490. [Mexico.]
1864. *Polyphaga (Homœogamia) Mexicana* Saussure, Mém. l'Hist. Nat. Mexique, IV, p. 226. [Warm lands of the Eastern Cordillera; Orizaba, Mexico.]

[3] The distinguishing characters of the male of *H. azteca* are taken from Saussure, as that sex has never been examined by the author.

1865. *H[omæogamia] mexicana* Brunner, Nouv. Syst. Blatt., p. 360. [Oaxaca, Mexico.]
1868. *Polyphaga Mexicana* Walker, Catal. Blatt. Brit. Mus., p. 15. [Mexico.]
1870. *Homæogamia Mexicana* Saussure, Miss. Scient. Mexique, Orthopt., p. 108. [Eastern Cordillera, Mexico.]
1871. *Homæogamia Mexicana* Walker, Catal. Orth. Saltat. Brit. Mus., V, Suppl. Blatt., p. 3. [Mexico.]
1879. "*Polyphaga* (*Homæogamia*) *mexicana* Girard, Traité Ent., III, p. 62."
1893. [*Homæogamia*] *mexicana* Saussure, Revue Suisse de Zoologie, I, fasc 2, p. 296. No localities cited.
1894. *Homæogamia mexicana* Saussure and Zehntner, Biol. Cent.-Amer. Orthopt., I, p. 106. [Ventanas in Durango, Sinaloa, and Cordova in Vera Cruz, Mexico.]
1900. *Homæogamia mexicana* Rehn, Trans. Amer. Ent. Soc., XXVII, p. 85 [Jalapa, Vera Cruz, Mexico.]
1901. *Homæogamia mexicana* Rehn, Trans. Amer. Ent. Soc., XXVII, p. 220 [Jalapa, Vera Cruz, Mexico.]
1903. *Homæogamia mexicana* Rehn, Trans. Amer. Ent. Soc., XXIX, p. 5 (Part). [Jalapa, Vera Cruz, Mexico.]

Description.—♂. Body flattened, moderately elongate. Head completely hidden under the pronotum; interspace between the eyes about one-fourth that between the ocelli; antennæ equal to the body in length, setaceous. Pronotum elongate pentagonous, arched transversely, and supplied with a distinct median carina; the lateral sections shorter than the other dimensions, and converging posteriorly, the posterior border which is linear, being the longest; surface scabrous, the borders, beset with short hairs. Tegmina large, exceeding the abdomen by one-half of their length; surface coriaceous, sub-scabrous at base, and becoming membranaceous along the posterior (internal) margin, anterior margin hirsute; basal field broad, extending almost the whole length of the tegmina, nervures obscured in the basal portion discoidal field with the nervures sub-arcuate, ramose; anal field with the principal nervures arcuate, all involved in an irregularly connected mass by numerous cross branches. Wings about as long as the pronotum, apex rounded. Supra-anal plate with the apex bilobate, the dividing emargination being narrow and comparatively shallow; subgenital plate transverse, centrally emarginate; cerci short, sparsely hirsute. Tibiæ with three rows of spines on their upper surfaces, apical spurs six in number. Metatarsi of anterior limbs more than half as long, of median limbs half as long, and of posterior limbs less than half as long as their respective tibiæ.

General color reddish-brown, strongest on the pronotum and anal field of the tegmina. Head brownish-black, ocelli orange, and clypeus and labrum dull luteous; antennæ brownish, the extreme base blackish. Under surface and limbs reddish-brown, the apical section of the abdomen suffused with blackish. Pronotum frequently marked laterally with very dull reddish. Tegmina sprinkled with translucent spots,

which give a marbled appearance to the same; distal, sutural and apical regions with this mottling very indistinct, the spots of greatest size in the distal portion, and very minute proximally; marginal field uniformly colored.

Length of body 20–21 mm.; length of tegmina 26.5–30.5 mm.; width of tegmina 10–10.5 mm.; length of pronotum 6.5–7 mm.; width of pronotum 9.5–11 mm.

♀. "No resemblance to the male. The insect in repose has a regularly elliptical form, with the back normally inflated, recalling the form of *Corydia* or *Phoraspis*. Prothorax very broad, arched, corneous, unwrinkled, with the two borders regularly arcuate, though the anterior is stronger so than the posterior; the margins on the sides form a sharp dentiform angle, which is placed a little posterior; the disk with almost the same ridges as in the ♂, but not the impression. Elytra of the length of the abdomen, hard and corneous, resembling two valves, terminating in rounded points; the surface densely shagreened; the nervures as apparent as the principal veins in the corneous mass of the elytra, and very much branched; no anal ridge or only slightly indicated toward the internal (posterior) border of the elytra in the form of a sub-transparent line. Scutellum very slightly uncovered. Prothorax and elytra densely haired, especially on the borders. Abdomen broad; the penultimate segment very arcuate, the last with its posterior half strongly compressed, carinate, rostrate and divided, resembling two closed valves; supra-anal plate rounded and divided. Anal filaments slim and short.

"Body brown or blackish; tarsi testaceous. Prothorax and elytra brown, the latter marbled with much paler speckles.

"Length of body 25 mm., length of pronotum 8 mm., width of the pronotum 12.5 mm."

Larva: "The ♂ larvæ are a chocolate-brown color and are densely haired. On the disk of the pronotum the hairs form longitudinal lines which correspond to the furrows. The supra-anal plate is transverse, a little arcuate, bordered, divided by an emargination; the subgenital plate with the posterior border arcuate. The form is the same as in *Heterogamia*."

Distribution.—This species has been recorded from the States of Sinaloa, Durango, Vera Cruz and Oaxaca, Mex. In Vera Cruz it has been taken only in the Eastern Cordilleran region.

Remarks.—The series of five males of this species examined by the author exhibits no apparent difference, except a slight variation in

the shape of the pronotum, a condition found in most of the species o the genus.

Specimens Examined.—Five males; Jalapa, Vera Cruz, Mex. (Barrett). (Acad. Nat. Sciences Phila.)

Homœogamia Azteca Saussure.

1893. [*Homœogamia*] *azteca* Saussure, Revue Suisse de Zoologie, I, fasc. 2 p. 296. [Mexico.]

1894. *Homœogamia azteca* Saussure and Zehntner, Biol. Cent.-Amer., Orthopt., I, p. 106. [Omilteme, Guerrero, Mexico.]

1903. *Homœogamia mexicana* Rehn, Trans. Amer. Ent. Soc., XXIX, p. ; (Part). [Uruapan, Michoacan, Mexico.]

♂. "Antennæ rufescent. Pronotum fuscous or rufous, a little heavier granulate than in *H. mexicana*. Eyes sub-contiguous. Elytra castaneous at the base, sparsely tuberculate, from here densely sprinkled with small white maculations, tips griseous; veins of the discoidal area arcuate. Wings hyaline, humeral and discoidal veins partly fuscous; costal region beyond the middle infuscate, margin narrowly yellow; apical margin and part of the posterior very narrowly infuscate. Feet rufo-castaneous, coxæ and femora more or less testaceous. Posterior metatarsus of the ♂ equal in length to the other joints combined, longer than a fourth of the tibia. Abdomen castaneous, pallid at base, margins with fulvous fimbriæ, which are shining rufous. Cerci rufescent. Supra-anal plate testaceous, apex with a minute triangular incision, bilobate; sub-genital plate with the margin rufescent, broadly subsinuate, styles lateral.

"Length 21-23; elytra 32-34.5; pronotum 6.5-7.5, width of pronotum 10.75-12 millim."

♀. Size large; form elliptical; surface sub-scabrous. Head with the interspace between the eyes less than that between the ocelli antennæ short, slightly more than half the length of the body. Pronotum elliptico-fusiform; anterior margin strongly arcuate, posterior gently arcuate; lateral angles slightly produced posteriorly. Tegmina with the lateral margins parallel in the proximal half; apex subacuminate, narrowly rounded; veins and nervures indistinct and slightly marked. Scutellum considerably exposed. Abdomen broad flat. Supra-anal plate produced, rotundate, narrowly emarginate centrally. Sub-genital plate compressed, rostrate, divided; penultimate segment with the apical margin triangularly arcuate. Metatarsi in no case exceeding half the length of their respective tarsi.

General color dull blackish-brown, obscurely blotched with yellowish brown. These blotches are larger toward the apex of the tegmina. Under surface dull red-brown; coxæ, limbs, abdomen, terminal

plates, labrum and basal joints of the antennæ sprinkled with dull golden hairs. Head except labrum and lower half of clypeus black; ocelli reddish-orange; eyes brown.

Length of body 22.7 mm.; length of tegmina 21 mm.; greatest width of tegmina 9.5 mm.; length of pronotum 8.5 mm.; width of pronotum 14 mm.

Distribution.—This species has been previously recorded only from Omilteme, Guerrero, Mex. The female from Uruapan, Michoacan, which is here described, extends the range somewhat to the north.

Specimens Examined.—One female; Uruapan, Michoacan, Mex. (Rhoads.) (Acad. Nat. Sciences Phila.)

Subgenus **ARENIVAGA** n. subg.

Subgeneric Characters.—♂. Size medium to rather small. Tegmina with the lateral margins gently arcuate; marginal field narrow, equal to one-fourth of the sub-basal width of the tegmina; veins in the distal portion of the discoidal field obliquely transverse, straight. Tarsi very slender and elongate; metatarsi of median limbs about as long as the tibiæ.

♀. Adult unknown.

Type.—*Homœogamia bolliana* Saussure.

Homœogamia bolliana Saussure.

1893. [*Homœogamia*] *Bolliana* Saussure, Revue Suisse de Zoologie, I, fasc. 2, p. 296. [Texas.]
1894. *Homœogamia bolliana* Saussure and Zehntner, Biol. Cent.-Amer., Orthop., I, p. 107. [New Mexico; Texas.]
1900. [*Homœogamia*] *bolliana* Scudder, Proc. Davenport Acad. Nat. Sci., VIII, p. 11. [Texas; New Mexico.]
1902. *Homœogamia bolliana* Rehn, Trans. Amer. Ent. Soc., XXVII, p. 331. [Round Mountain, Texas.]
1902. *Homœogamia bolliana* Scudder and Cockerell, Proc. Davenport Acad. Sci., IX, p. 19. [New Mexico; Las Cruces, N. M.]

♂. Size medium; form elongate-elliptical; surface finely punctulate on the pronotum, tegmina sub-coriaceous. Head with the interspace between the eyes not more than one-half of that between the ocelli; ocelli large, their upper surface in contact with the eyes; antennæ about equaling the body in length, basal joint comparatively large. Pronotum fusiform or elongate pentagonous, the two extremes connected by numerous intermediates; the anterior margin is generally more arcuate than the posterior, though in the elongate pentagonous type they are sub-equal; median section with two narrow sub-parallel, centrally placed impressed lines, which are supplemented posteriorly by two laterally placed, curved impressed areas; surface of the pronotum and anterior margin hirsute. Tegmina elongate, apex rounded;

anterior margin with short hairs, the surface of the whole tegmen with short, closely adpressed hairs; basal field without very distinct nervures; nervures of the discoidal field straight, oblique, parallel, seldom bifurcate; anal sulcus strongly arcuate; anal field nervures distinct and connected by numerous short cross nervures. Wings apically rounded, anterior margin straight in the proximal two-thirds. Abdomen broad, flattened, segments slightly projecting laterally. Supra-anal plate produced, sub-truncate; median portion with a shallow, triangular emargination. Sub-genital plate with the posterior margin sub-truncate; median portion with a very shallow, broad emargination. Cerci depressed, tapering, exceeding the anal plates in length. Metatarsi of anterior limbs slightly exceeding the tibiæ in length; of median limbs equal to the tibiæ; of posterior limbs exceeding half the length of the tibiæ.

General color reddish-brown, strongest on the central portion of the pronotum. Anterior and lateral margins of the pronotum pale yellowish, translucent. Tegmina sprinkled with small irregular blotches of umber; anterior margin reddish-brown, which is also the color of the hairs on the pronotum and tegmina. Head black; basal joints of antennæ and ocelli yellowish-orange. Under surface of abdomen, limbs, labrum and lower half of clypeus pale yellowish-brown; apical section of abdomen suffused with dull brownish.

Length of body 14.5–19.5 mm.; length of tegmina 19–24.2 mm.; greatest width of tegmina 7.5–10 mm.; length of pronotum 5–6 mm.; width of pronotum 7.5–9.2 mm.

♀. Fully adult condition unknown.

Larva.—Form ovate, the apex anterior; surface punctulate, the margins of the pronotum, thoracic and abdominal segments, as well as the surface of the body supplied with short stiff hairs. General color reddish-brown to brownish-black, the anterior and lateral margins of the pronotum touched with yellowish or whitish. Lower surface reddish-brown, strongest on the apex of the abdomen. Abdomen sometimes bearing a longitudinal row of black blotches on each side.

Distribution.—This species is apparently rather generally distributed over Texas. Specimens in the material examined are from Shovel Mount, Burnet county; Round Mountain, Blanco county; Austin, Travis county; San Marcos, Hays county; Devils River and Pecos High Bridge, Valverde county. The U. S. National Museum collection also contains specimens from Victoria, Victoria county; Dallas, Dallas county, and Carrizo Springs, Dimmit county. The only definite record from New Mexico is from Las Cruces, Donna Ana county. The species

is seen to extend from east central Texas to the Rio Grande Valley in New Mexico, and from the Red River region to south central Texas.

Remarks.—This species exhibits a great variation in size, and also in the shape of the pronotum.

Specimens Examined.—Nineteen males, eight larvæ:

14. Shovel Mount, Burnet county, Tex. September 2–October 29, 1901. (Schaupp.) (Acad. Nat. Sciences Phila.)
4. Round Mountain, Blanco county, Tex. (Schaupp.) (Acad. Nat. Sciences Phila.)
2. Austin, Travis county, Tex. Feb. 19, 1903. (Wheeler.) (Acad. Nat. Sciences Phila.)
1. San Marcos, Hays county, Tex. (Pilsbry.) (Acad. Nat. Sciences Phila.)
2. Devils River, Valverde county, Tex. (Pilsbry.) (Acad. Nat. Sciences Phila.)
2. Pecos High Bridge, Valverde county, Tex. (Pilsbry.) (Acad. Nat. Sciences Phila.)
2. Texas. Riley Coll. (U. S. N. M.).

Homœogamia erratica n. sp.

Type. — ♂; Prescott, Yavapai county, Ariz. June 10, 1902. (Oslar.) (Acad. Nat. Sciences Phila.)

Differing from *bolliana* in the smaller size, the greater interspace between the eyes (which is much more than half that between the ocelli, instead of half or less than half), the obscure character of the nervures of the distal portion of the marginal field, and more forked structure of the nervures of the distal portion of the discoidal field.

Description.—♂. Size rather small; form acute elliptical; surface sub-coriaceous. Head with the interspace between the eyes slightly less than that between the ocelli; ocelli very large, and in contact with the eyes along their superior margins; antennæ almost equal to the body in length; basal joint rather elongate. Pronotum sub-triangular, the basal line being represented by the posterior margin; posterior margin very broadly arcuate, lateral angles rounded; anterior margin and surface covered with hairs, those on the margin being rather long, and those on the surface very short. Tegmina elongate, the apex well rounded; proximal portion of the anterior (lateral) margins sparsely haired; basal field with the nervures but slightly marked distally, not visible in the proximal portion; nervures of the discoidal field parallel, oblique, straight, frequently bifurcate; anal sulcus rather deep, strongly arcuate. Wing reaching the tips of the closed tegmina, apex broadly rounded. Supra-anal plate produced, with a median triangular emar-

gination. Sub-genital plate produced, rounded, with a shallow, rotundate, apical emargination. Cerci short, depressed, not exceeding the sub-genital plate in length.

General color brownish-gray, the pronotum with a few median marks of dull brown. Tegmina obscurely dusted with irregular blotches of brownish. Head black, except the labrum, clypeus, mandibles and inter-antennal area which are yellowish-white; ocelli very pale amber; antennæ pale brownish, except the basal joint which is yellowish-white. Limbs and under surface very pale sandy brown; spines on the former rich reddish-brown.

Length of body 14.5 mm.; length of tegmina 18 mm.; greatest width of tegmina 7 mm.; length of pronotum 4.5 mm.; width of pronotum 6.2 mm.

♀. Unknown.

Distribution.—This form is known only from Prescott and Tucson, Ariz.

Remarks.—This species presents some considerable variation in size, and also in the intensity of the coloration, The specimens from Prescott are much grayer than the Tucson specimen, which is a pale straw-brown in color.

Specimens Examined.—Three males:

2. Prescott, Yavapai county, Ariz. June 10, 1902. (Oslar.) (Acad. Nat. Sciences Phila.)

1. Tucson, Pima county, Ariz. June 22. (U. S. N. M.)

Homœogamia apacha Saussure.

1893. [*Homœogamia*] *apacha* Saussure, Revue Suisse de Zoologie, I, fasc. 2, p. 296. [Chihuahua, Mexico.]

1894. *Homœogamia apacha* Saussure and Zehntner, Biol. Cent.-Amer., Orthopt., I, p. 107. [State of Chihuahua, Mexico.]

Description.—♂. Size small; form elongate ovate; surface sub-coriaceous. Head with the interspace between the eyes equal to that between the ocelli; antennæ not quite equal to the body in length. Pronotum triangular, the posterior margin longer than the other sides; surface covered with short appressed hair, the anterior margin with them much the longer. Tegmina elongate with the apex well rounded; basal field comparatively broad, the nervures distinctly visible in all but the extreme basal portion; nervures of the discoidal area rather irregular, frequently forked. Wings with the apex sub-acuminate. Supra-anal plate produced, rounded, deeply divided apically. Sub-genital plate produced, apically with a broad, shallow, triangular emargination. Cerci slightly longer than the sub-genital plate, appressed acuminate. Anterior metatarsi longer than the tibia; median meta-

tarsi not more than two-thirds the length of the tibia; posterior metatarsi slightly more than half the length of the tibia.

General color wood-brown, marked on the pronotum with a darker shade of same color; hair on the pronotum red-brown. Tegmina obscurely mottled with general tint, the lighter spots being sub-hyaline, except in the anal and basal section of the discoidal field. Color of the under surface and limbs pale wood-brown, darkest in the anal region and on the spines of the limbs.

Length of body 11.7–15.2 mm.; length of tegmina 14–18; greatest width of tegmina 6–7; length of pronotum 3.7–4.5; width of pronotum 5.2–6.5.

♀. "(Nymph?) Rufo-ferrugineous, apterous, head and feet testaceous. Supra-anal plate transverse, margin little arcuate, slightly incised. Cerci tuberculiform. Last ventral segment flat, rounded, both sides sinuate, produced in the centre. Length 13; pronotum 4.6; width of pronotum 7 millim."

Distribution.—The series examined includes specimens from Phœnix, Tempe and Fort Grant, Ariz. These with the type locality, Chihuahua, cover the known distribution of the species.

Remarks.—The most striking variation in the specimens examined appears to be that of size. The coloration appears, from the specimens at hand, to be quite constant.

Specimens Examined.—Five males:

2. Fort Grant, Graham county, Ariz. July 17 and 22. (Hubbard.) (U. S. N. M.)
2. Phœnix, Maricopa county, Ariz. April 29, 1902. (Oslar.) (Acad. Nat. Sciences Phila.)
1. Tempe, Maricopa county, Ariz. April 26, 1902. (Oslar.) (Acad. Nat. Sciences Phila.)

Subgenus **EREMOBLATTA** n. subg.

Subgeneric Characters.—♂. Size small. Vertex of the head with a distinct angular transverse ridge. Tegmina with the nervures in the anal field very distinct. Median and posterior tibiæ with seven apical spines. Supra-anal plate very broadly emarginate apically.

♀. Unknown.

Type.—*Homœogamia subdiaphana* Scudder.

Homœogamia subdiaphana Scudder.

1902. *Homœogamia subdiaphana* Scudder, Proc. Davenport Acad. Sci., IX, p. 19. [Las Cruces, N. M.]
1902. *Homœogamia subdiaphana* Rehn, Proc. Acad. Nat. Sciences, Phila., LIV (1902), p. 717. [Alamogordo and Highrolls, N. M.]

♂. Size small; form slender and elongate. Head with the inter-

space between the eyes slightly greater than that between the ocelli; vertex with a distinct transverse ridge which divides the apical from the inferior surface of the head; antennæ slender, filiform, shorter than the body. Pronotum sub-triangular; surface velvetinous and sometimes haired; the posterior margin broadly arcuate, the anterior semicircular; both margins closely haired, those of the anterior margin much longer than on the posterior; lateral angles obtuse, inconspicuous. Tegmina with the surface glabrous, the distal half membranaceous; apex sub-acuminate, rounded; anterior (lateral) margin basally supplied with long hairs; marginal field with the nervures absent in the proximal portion; discoidal field with the nervures obliquely parallel, almost longitudinal; anal field with the nervures distinctly visible and strongly arcuate. Tarsi with seven apical spurs. Sub-genital plate with the apex broadly emarginate, the lateral shoulders produced into distinct dentiform processes, the intervening diastema being of moderate depth and evenly rounded. Cerci flattened, very short.

General color wood-brown. Head blackish; ocelli amber-yellow. Pronotum with the anterior and lateral margins pale yellowish, the hair, which is present on the margins and sometimes on the disk, being of the same tint; disk blackish with two large lateral and one small medio-posterior dot of red, which are more or less conspicuous. Tegmina with the general tint strongest on the nervures of the proximal half of the tegmina. Under surface yellowish-brown, suffused with darker brown in the anal region.

Length of body 9.5 mm.; length of tegmina 14 mm.; greatest width of tegmina 5 mm.; length of pronotum 3–3.5 mm.; width of pronotum 4.2–4.5 mm.

♀. Unknown.[4]

Larva: Form ovate, the abdomen very broad. Pronotum similar to that of the male in general outline. Supra-anal plate transverse, the posterior margin rounded and centrally emarginate. General color wood-brown, edged on the pro- and mesonotum with ochraceous. Pro-, meso- and metanotum centrally ornamented with blotches of ochraceous, the penultimate abdominal segment bearing lateral blotches of the same tint.

Distribution.—This species has been recorded only from the Rio Grande Valley at Las Cruces, N. M., and the San Augustine Plain

[4] The specimen described by the author (*Proc. Acad. Nat. Sci. Phila.*, LIV (1902), p. 717) as a female is in a larval condition and the sex is uncertain.

and foothills of the Sacramento Mountains at Alamogordo and Highrolls, Otero county, N. M.

Remarks.—This species is so peculiar and distinct from the other forms of the genus that it is easily recognized. The series examined is quite uniform in size, and the color differences are very slight.

Specimens Examined.—Eleven; ten males, one nymph:

10. Alamogordo, Otero county, N. M. April 11–June 6, 1902. (Viereck and Rehn.) (Acad. Nat. Sciences Phila.)

1. Highrolls, Otero county, N. M. June 13, 1902. (Viereck.) (Acad. Nat. Sciences Phila.)

Unidentified Forms.

Polyphaga (Homeogamia) brasiliana Saussure.

1864. *Polyphaga* (*Homeogamia*) *Brasiliana* Saussure, Mém. l'Hist. Nat Mexique, IV, p. 228.

1868. *Polyphaga Brasiliana* Walker, Catal. Blatt. Brit. Mus., p. 15.

"Nymphe ♂. Corps un peu voûté, suborbiculaire, finement striolé ou ponctué. Le premier arcticle des antennes médiocrement long, assez gros; le deuxième petit; le troisième deux fois plus long. Prothorax large et court; son bord antérieur à courbure obtuse, subangulaire au milieu; les angles latéraux très-aigus; le bord posterieur un peu arqué, subsinné avant les angles. Abdomen aplati, large, à bords faiblement dentés; segments dorsaux 8, 9 très-distincts, découverts; le bord posterieur du 7me presque en demi-cercle; en dessous le pénultième segment petit, très-arqué; ses deux extrémités presque cachées sous le précédent. Plaque sous-génitale ayant son bord postériéur en forme d'angle obtus; ce bord fortement dépassé par la lame sousanale fendue, laquelle est à son tour débordée par la plaque suranale; celle-ci transversale, à bord postériéur presque droit, et un peu fendu; la face supérieure cannelée au milieu. Styles anaux très-distincts. Pattes grêles, allongées; épines tibiales longues et grêles.

"Couleur d'un marron ferrugineux, presque testacée en dessous; vertex, front et labre supérieur, offrant une bande brune; antennes ferrugineuses, plus foncées en dessus; bords du thorax ciliés de poils ferrugineux, et variés de testacé-jaunâtre: sur la ligne médiane chaque segment orné de deux joints jaunes; ces points se continuant sur l'abdomen en devenant plus vagues; les segments abdominaux ornés en outre de chaque côté d'une marque jaune et d'un point brun; te thorax en dessous jaune-testacé.

"Longueur du corps, 0,017: —largeur du prothorax, 0,0115; —id. de l'abdomen, 0,0145.

"*Habite:* Le Brésil."

Polyphaga æqualis Walker.

1871. *Polyphaga æqualis* Walker, Catal. Spec. Derm. Salt. Brit. Mus., V, Suppl. Catal. Blatt., p. 3.

"*Male*. Piceous. Head black; clypeus, palpi and antennæ red. Prothorax scabrous, transversely elliptical; anterior half of the border red; some longitudinal impressed lines in the disk. Pectus, legs, sides of the abdomen and hind borders of the segments tawny; femora setose beneath. Fore wings extending for full half the length beyond the abdomen, with numerous minute pale testaceous dots, occasionally with a large pale testaceous patch in the disk near the base. Hind wings pellucid; veins paler. Length of the body 8–9 lines; expansion of the fore wings 28–30 lines. The prothorax is regularly elliptical, and thus differs from that of *P. Mexicana*, in which the hind part is broader than the fore part, and is truncated on each side. *a–b*. South Mexico."

This is apparently a member of the genus *Homœogamia*, but cannot be positively identified. It is possibly a synonym of *mexicana*, as Walker's knowledge of the latter species must have been limited, as his statement regarding the form of the pronotum in that species is partially erroneous.

Homœogamia n. sp. Bolivar.

1890. *Homœogamia* n. sp. Bolivar, Ann. Soc. Ent. France (6), X, p. 137.

"Un seul exemplaire à l'état de larve.

"Possédant dans ma collection des individus à divers-degrés de dévelopement, je peus affirmer seulement que cette espèce ne se rapport pas à *H. mexicana* Burm., avec qui je l'ai comparée, ni à *H. brasiliana* Sauss., bien que cette dernière espèce ait été décrite sur un mâle à l'état de nymphe. Le pronotum est couvert de granulations miliaires, ses sillons dorsaux étant remplacés par de simple dépressions, ce qui donne à l'insecte un faciès un peu différent des autres *Homœogamia*.—Caracas.

"Je crois cette espèce nouvelle, mais ne possédant pas des individus bien dévcloppés, je ne la décris pas."

MOLLUSCA OF WESTERN ARKANSAS AND ADJACENT STATES, WITH A REVISION OF PARAVITREA.

BY HENRY A. PILSBRY.

Early in 1901 Mr. J. H. Ferriss explored for mollusks a portion of southwestern Missouri, western Arkansas, and some adjacent localities in the Indian Territory, the region covered lying mainly north of that exploited in 1900.[1]

The rugged topography of a portion of this region, and its elevation above the plains on all sides, have resulted in the evolution of many species and subspecies special to the tract. The general conditions of life are varied from those prevailing over the comparatively level States along the Mississippi, and with this change has come readjustment on the part of the snails. The mode of this readjustment I hope to study further when more material is available. From the data presented in this paper and my article of 1900 on the same fauna, it appears that—

(1) Species having a wide geographic range become much more variable in this district.

(2) Variation is usually *not indiscriminate, but in the large majority of individuals follows one or two definite lines of deviation* from the "normal" or widespread form.

(3) Various specific stocks show various degrees of deviation or differentiation from their widespread "normal" forms.

The first of these propositions is exemplified by a large number of species, and would be noticed by any one possessing the material for comparison. The second point is one of some importance. It is illustrated likewise by many species, of which several may be taken as examples. *Gastrodonta demissa* is a snail ranging from "Western Pennsylvania to Georgia, west to Arkansas and Eastern Texas."[2]

[1] See Pilsbry in these *Proceedings* for 1900, pp. 449–459, and especially Ferriss, *Nautilus*, XIV, pp. 25–31, July, 1900, where the country is described, and many species not in other lists are noted. Information bearing on the molluscan fauna of adjacent districts may be found in the following papers: F. A. Sampson, "Shells of Pettis county, Mo.," in *Bull. I, Sedalia Natural History Society* (1885): "Preliminary List of the Mollusca of Arkansas," *Ann. Rep. Geol. Survey of Arkansas* for 1891, Vol. II, pp. 179–199 (1893); C. T. Simpson, "Notes on Some Indian Territory Land and Fresh-water Shells," in *Proc. U. S. National Museum*, 1888, pp. 449–454.

[2] Pilsbry, *Catal. of the Land Shells of America*, p. 28 (1898).

In this area it is not known to vary much east of the Mississippi Several years ago I received a number of specimens from Arkansa which differed from all previously known in having the whorls so closely coiled as to make the axis quite imperforate, and at the same time the whole shell was flatter. This form I called *Gastrodonta brittsi*. Subsequently, specimens from another Arkansan locality came to my hands, in which there was a lamella within the aperture a structure unknown in the species elsewhere. These became *G. demissa* var. *lamellata*. The abundant series collected by Mr. Ferriss since these supposed subspecies were discriminated, shows that in their area they coexist with snails indistinguishable from Eastern *G. demissa*, and that the variation of that species in this area is not indeterminate, but toward the one or the other of these two diverse modes of modification.

Polygyra monodon is in the same case. In western Arkansas three weakly differentiated forms occur, which have been named *aliciæ*, *friersoni* and *imperforata*. All are closely related to, and doubtless descendants of, the widespread *P. m. fraterna*; and all three occur around some localities.[3] But in examining several hundred individuals I did not find the variation indiscriminate, even in a small percentage of the snails, but always toward one or the other of the three differentiation-lines signalized by the three subspecific names, without individuals intermediate between them, or otherwise modified, as the species is in some other regions.

Without further multiplying instances, I may say that while in certain districts, usually of rugged and varied topography, widespread species of snails become locally variable, there has come to my notice but little of the multifarious variation called for by the theory of natural selection. What strikes one is the uniformity with which modifications, varying in amount, yet follow definite paths.

This impression left by studies of the snails of the United States, I would never have gained from what I have seen of certain Antillean genera, such as *Cerion* or the Jamaican *Urocoptis*. In these groups there seems to be great and multifarious variation, without elimination of intermediate forms, thus making specific lines merely arbitrary.

List of Species.

Localities marked with an asterisk (*) in this list are given on Mr. Ferriss' authority.

[3] See my former paper on Arkansan snails, *Proc. A. N. S. Phila.*, 1900, pp. 454–456, where the data on distribution are given.

POMATIOPSINÆ.

Pomatiopsis lapidaria (Say).

Seligman, Barry county, Mo.

HELICINIDÆ.

Helicina orbiculata tropica (Jan.).

Seligman,* Mo.; Petit Jean,* Yell county, Ark.

HELICIDÆ.

Polygyra leporina (Gld.).

Poteau* and Antlers,* I. T.

Polygyra dorfeuilliana (Lea).

Springfield, Green county, southwestern Missouri. Typical *P. dorfeuilliana sampsoni* Weth., 7.8 to 8.2 mm. diam. Seligman, Barry county, southwestern Missouri. Typical *P. d. sampsoni*, diam. 8–9 mm.

Chester, Crawford county, Ark. Varying from 6½ to 8 mm. diam., some specimens showing transition toward var. *sampsoni* in width of the umbilicus.

Rich Mountain, Polk county, Ark. Specimens typical, 7–7¾ mm. diam.

Hot Springs, Garland county, Ark. Like the preceding.

Carrion Crow Mountain, in Gum-dog township, Pope county, Ark. This is about ten miles north of Petit Jean Mountains. Rather heavy specimens, 6.2 to 7.6 mm. diam., with the lower lip-tooth somewhat prominent in a basal view.

Tushkahoma, I. T. The specimens vary from 6.2 to 8 mm. diam., are rather solid and somewhat more striate beneath than in typical *dorfeuilliana*. The parietal tooth is rather small. The umbilicus varies from that of typical *dorfeuilliana* to as wide as *sampsoni*, so that there is here a perfect transition between the two. A large series was collected.

Antlers, Choctaw Nation, I. T. Three specimens measuring 6, 6.2 and 7.5 mm. diam. The lip is much thickened, immersing the teeth, and the parietal tooth is unusually large and square.

In the largest shell the umbilicus is that of *sampsoni*, and the aperture less obstructed, diam. 8 mm.

Standley, Choctaw Nation, I. T. Diam. 7 to 7.5 mm., the specimens varying from *dorfeuilliana* to *sampsoni* in umbilicus. Aperture normal.

Poteau, Choctaw Nation, I. T. Rather solid, distinctly striate beneath, varying from 7.5 to 8.7 mm. diam., and from the small

umbilicus of *dorfeuilliana* to the widely open condition of *sampson* most of the specimens intermediate in size and umbilicus. A larg series.

In some portions of southern Missouri and adjacent counties (Arkansas, the specimens are larger than typical *dorfeuilliana*, an widely open beneath, showing over one whorl. They are usuall quite glossy, and rather weakly striate on the base. This form, va *sampsoni* Weth., seems to be quite distinct in this area. In the easter part of Indian Territory, the shells are rather heavier, more distinctl striate on the base, and wherever a large series was collected they var from the *dorfeuilliana* form, in which but one whorl or a little less i exposed beneath, to the *sampsoni* form of base; most specimens bein intermediate in these characters. This area therefore is one in whic differentiation has not taken place—a transition region. Cf. thes *Proceedings* for 1900, p. 449.

Polygyra jacksoni (Bland).

Springfield, Green county, and Chester,* Crawford county, Mo. Poteau* and Rich Mountain,* Ark.

Polygyra cragini (Call).

DeKalb,* Cleburne county, Ark.; Antlers,* I. T.

Polygyra neglecta Pils.

> *T. fallax* Say var. *minor*, Wetherby, Some Notes on American Land Shell: No. II, p. 11, in Journ. Cincinnati Soc. N. H., IV, December, 1881, p. 33: *Polygyra neglecta* Pils., Nautilus, XIII, p. 40 (August, 1899).

The above reference to Mr. Wetherby's work was overlooked b me, or not recognized as pertaining to this species, when I define *P. neglecta* in 1899. He says: "Years ago I received from Springfielc Mo., a small variety of this species [*Triodopsis fallax*], much lighte colored, with a thicker and heavier shell than the type, with th peristome reflected backward and rounded, and having a very distinc facies. I have recently received the same variety from Mr. Sampsoı who collected it at Eureka Springs."

The form would hardly be recognized from this note without spec: mens from the localities mentioned; and as several forms of the genu have already been called "var. *minor*," it will probably not be advis able to revert to that name. Mr. Ferriss procured specimens a Seligman, Barry county, and Springfield, Green county, both in south western Missouri.

Polygyra inflecta (Say).

Petit Jean, Yell county, Ark.; diam. 9–11 mm. Seligman, Mo. normal specimens with strong teeth, diam. 10 mm., and a very distinc

race in which the teeth are much reduced, though still the lip-teeth are decidedly stronger than in *P. edentata*. Specimens measure—

Alt. 5.3, diam. 11.5 mm.; whorls 4¾.

Alt. 5, diam. 9.5 mm.; whorls 4½.

The last whorl is somewhat more costulate behind the lip than usual in *P. inflecta*. This form may be called var. *media*.

P. inflecta was taken also at Rich Mountain,* Hot Springs* and Carrion Crow Mountain,* Ark.; Tushkahoma* and Standley,* I. T.

Polygyra edentata (Sampson).

Chester, Crawford county, western Arkansas. Two specimens sent measure 12 and 14 mm. diam.. and have 5 and 5½ whorls. Eighteen were taken at this locality.

Polygyra albolabris alleni (Wetherby).

Mesodon albolabris Say, and var. *minor* A. G. Wetherby, Some Notes on American Land Shells, No. II, in Journ. Cincinnati Soc. Nat. Hist., IV, p. 11, December, 1881. Eureka Springs, Carroll county, Ark.

M. albolabris Say, F. A. Sampson, Bull. No. 1, Sedalia Nat. Hist. Soc., p. 19, 1885. Sedalia, Mo.

Mesodon albolabris Say, var. *alleni* (Wetherby) and var. *minor* Sampson, Mollusca of Arkansas, in Ann. Rep. Geol. Surv. of Ark., II, pp. 189, 190, 1893. Carroll, Benton, Sebastian, Crawford, Garland, Washington, White, Johnson, Nevada, and Independence counties, Ark.

Polygyra albolabris alleni Weth., Pilsbry, in these *Proceedings* for 1900, p. 451. Iowa and Arkansas.

All of the above references pertain, I believe, to a single widespread race of *P. albolabris*, varying in size and color almost as much as the Eastern form of the species, but in a broad view distinguishable from the latter by one, several or all of the following characters: The shell is thinner, *more depressed and more glossy;* the *spiral lines and other minute sculpture are weaker*; the lip is *narrower*, *rounded rather than flat*, with a weaker less angular rib within; the low basal tooth is frequently more distinctly defined. Distribution, west of the Mississippi from southern Minnesota to Arkansas, and eastward in the South to Jackson county, in northern Alabama.

In the North, *P. albolabris* replaces *alleni* east of the Mississippi river, in Illinois. I have seen typical *P. albolabris* from west of the Mississippi only from Winfield, Henry county, in southeastern Iowa, where it coexists with var. *alleni*. Owing to the frequent cutting of "ox-bows" by the Mississippi, and the consequent transfer of islands from one to the other side of the stream, even that great river is no bar to the distribution of snails inhabiting lowland forests; and somewhere along the immediate vicinity of the Mississippi the areas of *albolabris* and *alleni* probably overlap, with perhaps a belt of undifferentiated intermediate forms.

Specimens of *P. a. alleni* from Albert Lea, Minn., the most northern point from which I have seen the variety, those from Winfield, Henry county, in southeastern and Des Moines in central Iowa, are yellow or whitish, small, averaging 23 mm. in diameter; 70 per cent. of those seen measuring from 22 to 24 mm., the extreme of size being 21 and 26 mm., these extremes represented by very few specimens. I have below plotted the curve obtained from measuring the diameters of a lot of 50 specimens from Des Moines, Ia., collected by Mr. T. Van Hyning. The number of individuals is probably sufficient to afford a perfectly normal curve for the particular place these were obtained; but the specimens from Albert Lea, Minn., and Winfield, Ia., though few in number, are so similar that I would not expect much difference in their curves.[4]

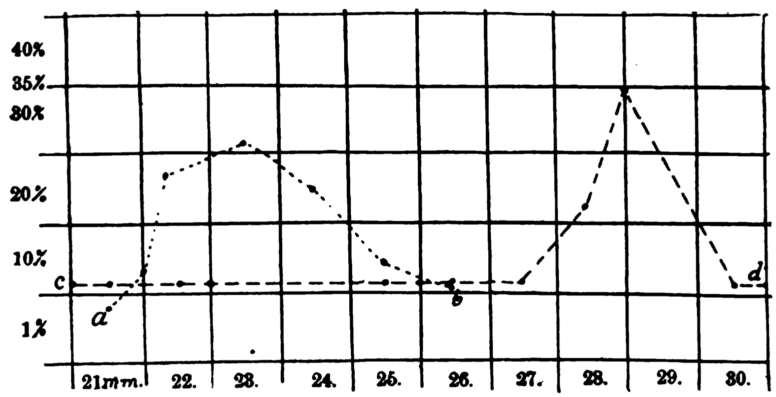

Fig. 1, *a–b*, diameter variation curve of 50 shells of *Polygyra albolabris alleni* from Des Moines, Ia.; *c–d*, 18 shells from Seligman, southwestern Missouri.

This contrasts strongly with the conditions in western Arkansas,

[4] This curve is remarkably symmetrical, the average diameter of the lot, obtained by dividing the sum of their diameters by the number of specimens, practically coinciding with the diameter of the greatest number of individuals, represented by the mode or highest point of the curve. Variation in size is about equal toward both minimum and maximum. Of course it is understood that exact measurements of the shells would efface the angles of the "curve," especially near the mode. I neglected fractions smaller than ½mm., as in organisms of this size greater exactness would be mere pedantry.

A widely different condition is seen in the other curve, in which the average diameter is less than that of the greatest number of specimens. It must be constantly borne in mind that the curve of the Seligman lot is probably widely different from what a series of 50 or 100 specimens from that locality would produce; but still the absence of individuals between 22 and 25 mm. diameter, together with the fact that other localities in western Arkansas show a large and a small form, leads me to suspect that a sufficient series would form a bimodal curve, the minor mode remote from the other, and probably near the 21 mm. lien.

southwestern Missouri and the Indian Territory, where in many localities there is a very much wider variation in absolute size. Thus, in a series of 18 shells from Seligman, Barry county, southwestern Missouri, the variation is from 20½ to 30½ mm.; the smallest being smaller than the extreme of the Des Moines lot of 50 shells, while about 70 per cent. of the shells are larger than the largest from Des Moines.

Of course no normal curve can be plotted from so small a series as 18 specimens; but in view of similar variation in other smaller lots, the general features of the curve are indicative of the wide range of individual variation. The specimens in the present collection from Missouri and Arkansas are as follows. There are not enough from any one place to make their variations of much significance, but I give the data for what they are worth:

De Soto, Jefferson county, Mo. A single thin, small specimen of typical *alleni*, diam. 23 mm.

Seligman, Barry county, southwestern Missouri. See notes above. Many of the specimens are large, 28 to 30½ mm. diam.

Chester, Crawford county, Ark. Three specimens measuring 30, 26 and 23 mm. diam. The smaller ones thin, like *maritima*, the larger one strong.

Hardy, Sharp county, northeastern Arkansas. Four specimens, measuring 21, 22, 24 and 26 mm. diam.

Hot Springs, Garland county, Ark. A single specimen, diam. 29½ mm., less depressed than usual.

Rich Mountain, Polk county, Ark. Rather heavy, large specimens, diam. 30 mm or more.

Carrion Crow Mountain, Pope county, Ark. Diam. 24 to 27½ mm.; rather light, with the usual narrow peristome.

Tushkahoma, Choctaw Nation, I. T. Four large specimens only, measuring 28½, 28½, 29½, 31½ mm. diam. The spire is a little higher than usual, and there are nearly 5½ whorls. The peristome is typical of *alleni*.

Standley, Choctaw Nation. A single shell similar to the above, diam. 31 mm.

In Kansas *P. alleni* occurs in Shawnee county, and at Quenemo, Osage county. The specimens resemble those from Iowa. None have been seen from southwestern Arkansas or Texas.

East of the Mississippi, specimens of typical *alleni*, resembling those of Missouri, are in the collection of the Academy from near Decherd, Franklin county, in middle Tennessee, near the Alabama boundary,

received from Mr. A. G. Wetherby, and from Chattanooga, collecte by Mr. S. N. Rhoads. At the latter place it coexists with a heav form of *albolabris*, though the two do not occur together.

Polygyra albolabris fuscolabris nov.

Finally, near Woodville, Jackson county, in northern Alabama, form was collected several years ago, by Mr. H. E. Sargent, whic seems to be the culmination of the *alleni* type, with some speci features which make it advisable to treat it as a local variety, under th new name *P. albolabris fuscolabris*. The shell is very large, alt. 1! diam. 34 mm., to alt. 21, diam 38 mm.; depressed, glossy and finel striate, as in *alleni* with the aperture more oblique and the lip na rower than in *albolabris* of the same size. The basal lip bears a lov flat-topped, wide tooth near the columella, and the outer lip is tinte fleshy-brown (fading in cabinet specimens). Whorls 5½.

This particular form is yet known from Mr. Sargent's collection only. A large, heavy form of *P. albolabris*, probably referable to va *major*, also occurs near Woodville. *P. a. fuscolabris* bears such a rela tion to *alleni* as *major* to *albolabris*, or var. *normalis* to typical *I andrewsæ*.

Polygyra zaleta Binn. (*exoleta* Binn.).

Seligman, Barry county, Mo. Small specimens, 20–22 mm. diar It is in the collection of the Academy from two other localities i Arkansas: Eureka Springs (F. A. Sampson) and Mabelvale (C. W Johnson).

Polygyra indianorum (Pilsbry).

P. divesta indianorum Pils., Nautilus, XIII, p. 39 (August, 1899). Ferris Nautilus, XIV, p. 28 (July, 1900).

Tushkahoma, Choctaw Nation, I. T. Five specimens 25½ to 28 mm diam.; also Standley,* I. T. Further experience with this form con vinces me that it is quite distinct from *P. divesta*; a course prompte by Mr. Ferriss. As he has collected and examined more specimen than any one else, I am the more disposed to depend upon his judg ment.

Polygyra divesta (Gld.).

Pilsbry, Nautilus, XIII, p. 38 (1899).

Chadwick, Christian county, and Seligman, Barry county, Mo In Arkansas at Chester, Crawford county; Petit Jean, Yell county Hot Springs, Garland county; Carrion Crow Mountain, Pope county There is but little variation in the specimens from Arkansas, all o which are typical. At Seligman, in southwestern Missouri, the siz

varies, the average being smaller than Arkansas shells. The smallest specimens measure 15 mm. diam., whorls 4½; the largest 18 mm. with 4¾ whorls. At Chadwick, Mo., the smallest specimens I have seen were taken, varying from 14½ to 17½ mm. diam.

Polygyra binneyana Pils.

Pilsbry, Nautilus, XIII, p. 38 (August, 1899); Proc. A. N. S. Phila., 1900 p. 451; Ferriss, Nautilus, XIV, p. 28 (July, 1900).

Poteau,* Choctaw Nation, I. T.; Rich Mountain,* Polk county, Ark.

Polygyra appressa perigrapta Pils.

Chester, Crawford county, and Petit Jean, Yell county, Ark. Specimens typical but rather small, diam. 18–19½ mm. A specimen was also sent from Gulfport, Miss.

Polygyra thyroides (Say).

Cf. Proc. A. N. S. Phila., 1900, p. 452.

Seligman, Barry county, Mo. Small specimens of the globose *bucculenta* form; diam. 15½ to 18 mm; umbilicus generally nearly covered, as in *P. clausa*, but sometimes entirely closed. The specimens have a decided resemblance to *P. clausa*. Two out of eight adults have a small parietal tooth.

Antlers, Choctaw Nation, I. T.; Poteau, in the same district, near the Arkansas boundary. Small specimens, diam. 18 mm. Carrion Crow Mountain, Pope county, also small.

At Hardy, Sharp county, in northeastern Arkansas, two specimens of a small form of *thyroides* were taken, measuring 17½ and 18 mm. diam., and closely resembling *P. clausa*, from which they differ, however, in the more "dished" lip, less elevated contour, and slight angulation of the front of the last whorl. One of these specimens is almost imperforate.

Polygyra clausa (Say).

Springfield, Green county, Mo. The specimens are quite typical. This is, so far as I know, the southwestern extreme of the known distribution of the species. Two specimens were taken at Hardy, in northeastern Arkansas. In Missouri and Arkansas *P. clausa* is sometimes very difficult to distinguish from the small form of *P. thyroides*, which occurs in that region. This is the more remarkable because the two species in other parts of the country are quite readily distinguishable by the shells.

Polygyra pilsbryi Ferriss. Pl. IX, figs. 1, 2, 3.

Ferriss, Nautilus, XIV, p. 29 (July, 1900).

Rich Mountain Station, Polk county, Ark., is thus far the only local-

ity for this species, which in its cuticular processes is the most aberra of the genus. The original specimens were denuded of the long fi ments characteristic of the species in a fresh condition, and hence t published description did not mention them. These filaments ɛ long, more or less curved, flexible, and arise in triangular lami from the narrow riblets of the surface. They stand in three princi rows on the body-whorl, one at the periphery, the others above a below it, the upper one ascending the spire midway between sutur The inner 2½ or 3 whorls are free from filaments. The base is encircl by two minor and imperfect rows inside the subperipheral one.

In all other Stenotremes except *P. barbigera* (Redf.) the cuticu hairs form a comparatively close pile, and they are arranged in obliq sweeps, or are merely adnate and prostrate appendages trending the direction of growth-striæ. In no other do they form a series circular, concentric fringes. *P. barbigera* has a single fringe of simi filaments, usually persisting at the suture only.

Polygyra labrosa (Bland). Pl. IX, figs. 4, 5, 6.

> *Helix labrosa* Bld., Ann. Lyc. Nat. Hist. of N. Y., VII, 430 (1861).
> *Stenotrema labrosum* (Bld.), Binney, Man. Amer. Land Shells, 274.

Petit Jean Mountain, Yell county, western Arkansas; Seligm Barry county, southwestern Missouri. Also Chester,* Hot Spring Carrion Crow Mountain, Ark.*

Figured for comparison with the other Southwestern Stenotrem the figures published hitherto being in outline and quite inadequate exact comparisons. The Tennessee specimens I have seen are m distinctly striate beneath and much paler than those from Arkans the aperture white. From the data now available it looks as thou the range of *P. labrosa* is discontinuous, being interrupted by a w strip of low country along the Mississippi; but its distribution Tennessee and Alabama calls for further investigation, as no defin locality in either State is given, either in the books of Mr. Binney on the labels of specimens from Bland in the Academy collecti Sampson has reported *P. labrosa* from eleven counties in middle a western Arkansas.

Polygyra uncifera Pilsbry. Pl. IX, figs. 7, 8, 9, 10.

> *P. hirsuta uncifera* Pils., Proc. A. N. S. Phila., 1900, p. 453 (September 1900); Ferriss, Nautilus, XIV, p. 30, No. 139*c* (1900).

Polk county, western Arkansas, at Mena and the adjacent Chast Mountains, and Rich Mountain.

The peculiar structure of the peristome of this form certainly in cates a distinct species, and not, as I at first thought, a subspecies

P. hirsuta. Sometimes the parietal lamella is recurved at the outer end, hook-like, as in the type (fig. 7), but in most of the specimens from Rich Mountain the recurved part is quite separate from the lamella, standing apart as a short entering denticle (figs. 8, 9, 10). I have observed no other variation of note except in the size and number of whorls, the Rich Mountain series measuring from 6.5 mm. diam. with 4⅔ whorls to 8.2 mm. with 5½ whorls. The "fulcrum" is quite long, as in typical *hirsuta*, and notched above and below.

Polygyra hirsuta has not been reported from Arkansas, so far as I know, and evidence is still wanting that it occurs west of the Mississippi south of Kansas and Pettis county, Mo., whence it is recorded by Sampson. I regard the specimens reported by Dr. Stearns from the "banks of Yaqui river near Guaymas"[5] as probably Eastern shells accidentally mixed with those from the locality named. The southwestern range of *P. hirsuta* is apparently much more limited than that of many of the Eastern snails.

Polygyra blandiana n. sp. Pl. IX, figs. 11, 12, 13.

Shell imperforate, depressed, *obtusely angular* at the periphery, the spire slightly convex, base much more convex, owing to the high position of the peripheral angle. Chestnut-brown; the surface rather glossy and partially dull; nearly smooth, having weak growth-wrinkles above, fainter on the base; *without hairs or their scars.* Whorls 4⅔, moderately convex, the last shortly deflexed in front. Aperture resembling, in general, that of *P. hirsuta*, but narrower; the outer end of the parietal lamina is abruptly bent inward, and its crest a little notched. The notch in the basal lip, which seems shallow in a basal view, is seen in front or oblique view to be deep, with a raised border. The outer curve of the lip is rather deeply notched. Fulcrum long, at a right angle with the aperture.

Alt. 4, diam. 8 mm.

Alt. 3.8, diam. 7 mm.

Springfield, Green county, southwestern Missouri, copiously; Seligman,* Barry county, Mo., 3 specimens.

This very distinct race differs from *P. hirsuta* in the following particulars: The shell is much more depressed and obtusely angular at the periphery; it shows no trace of hairs; the parietal lamella is more curved and stands nearer the basal lip, thereby causing the aperture to be narrower; the notch in the basal lip is larger, etc.

In a rather large series of shells, no specimens at all intermediate in characters were found.

[5] *Proc. U. S. Nat. Mus.*, XVII, 162 (1894).

Polygyra monodon imperforata Pils.

Proc. Acad. N. S. Phila., 1900, p. 455.

Rich Mountain, Polk county, Ark. The ordinary, widely distributed *P. m. fraterna* occurs in southwestern Missouri.

Polygyra monodon aliciæ (Pils.).

Drift débris of the Arkansas river, at Petit Jean Mountain, Yell county, Ark.; Hot Springs, Ark.; DeKalb,* Ark., and Antlers,* I. T.

BULIMULIDÆ.

Bulimulus dealbatus (Say).

Seligman, Barry county, Mo. Two gray-mottled specimens collected have the spire much longer than in ordinary *dealbatus*, and the whorls, except the last two, are more strongly striate. The form approaches var. *ragsdalei* to some extent.

PUPIDÆ.

Bifidaria armifera (Say).

Seligman, Barry county, Mo.

Bifidaria contracta (Say).

Seligman, Barry county, Mo.; Rich Mountain, Polk county, Ark. The season was not a propitious one for collecting minute snails, hence their scarcity in this collection.

ACHATINIDÆ.

Cochlicopa lubrica (Müll.).

Seligman, Barry county, Mo.

CIRCINARIIDÆ.

Circinaria concava (Say).

Petit Jean,* Yell county, Ark.

ZONITIDÆ.

Vitrea hammonis (Ström).

Rich Mountain, Ark.; Seligman, Mo.

Vitrea indentata (Say).

Poteau, Tushkahoma and Antlers, I. T.; Rich Mountain, Ark.; Carrion Crow Mountain, Pope county, Ark.; Seligman, Mo.

Section PARAVITREA Pils.

Paravitrea Pils., Nautilus, XI, p. 130 (March, 1898).
Taxodonta Pils., Nautilus, XI, p. 132 (March, 1898).

Shell depressed or discoidal, perforate or narrowly umbilicate, composed of *numerous closely coiled whorls*, usually *grooved radially* above;

thin and fragile; internally having obliquely radial laminæ, or rows or pairs of teeth, at intervals of a third of a whorl, some or all of them often wanting, especially in old individuals.

Genital system without dart sac. Radula with teeth of the central row tricuspid; two or three laterals on each side also tricuspid, the entocone raised high upon the mesocone, of which it forms a lateral spur. Marginal teeth of the usual simple and thorn-like form.

Snails of this group have the discoidal shape and *closely coiled whorls* of the typical (European) section of *Vitrea*, and they have also a dentition of the same type, which is remarkable for the peculiar mode of specialization of the lateral teeth. *Paravitrea* differs from typical *Vitrea* in the umbilicate axis and the development of teeth. The compact coiling of the numerous whorls sufficiently distinguishes *Paravitrea* from the *Hyalina* type of *Vitrea*, such as *V. hammonis*, etc.

The species of *Gastrodonta* protected by teeth, have only a single pair near the aperture, constantly added to in front and absorbed behind with growth of the shell; but in *Paravitrea* successive sets are formed to be absorbed later.

The adult or old individuals of species of *Paravitrea* usually absorb all the teeth, and form no new ones in the latest stages; or in some cases, as in *V. capsella*, teeth may be formed in occasional or rare very young individuals, while in the intermediate and later stages of growth none are developed. In a few other species, such as *V. clappi*, *V. simpsoni* and *V. placentula*, no teeth have yet been observed even in the young. If my interpretation of the facts is correct, such species as *V. andrewsæ* and *multidentata*, which commonly possess teeth in adults, are old, relatively unchanged types; while forms toothless at all stages are the most evolved. *Paravitrea thus consists of species and races in various stages of reduction and loss of teeth, but descendants from an ancestral stock which had them.*

Another modification of the ancestral radially toothed *Paravitrea* is seen in certain species in which even-edged or serrate radial ribs or lamellæ replace the rows of teeth. The irregular or serrate edge of this lamella in some individuals indicates that it has been formed by coalescence of a row of teeth, the intervals between them becoming filled up, exactly as in the *Clausiliidæ* of eastern Asia the lunella has been formed by coalescence of a primitive row of palatal plicæ.[6] In this phylum, too, the armature has been lost in some species and in some individuals of species normally toothed; and by acceleration, ex-

[6] See these *Proceedings* for 1901, LIII, p. 638.

ceedingly rare individuals of species which normally have rows of independent teeth acquire the radial barriers of forms more advanced in the scale of evolution. This is exemplified by *V. multidentata*, discussed in a previous paper,[7] and *V. andrewsæ*, mentioned below.

All this merely goes to show that *Paravitrea* is in a condition of rapid readaptation. Mutation takes place chiefly in two definite directions: (1) *Toward progressively earlier loss of internal armature, which culminates in toothless species*, and (2) *the formation of transverse barriers by coalescence of the teeth.*

Under these circumstances, the path of the systematist is an exceptionally thorny one, although to the evolutionist the group is full of interesting suggestions. No rigorous definitions are in order; and the distinction between "species" and "subspecies"—always more or less indefinite—becomes largely a subjective one when large series of specimens are studied. Only a series of individuals representing the whole life cycle, from youth to old age, can give one an adequate idea of the characteristics of the special form from any given locality.

Through the kindness of Mr. Ferriss and others, I have been able to study large series of most of the species, in addition to the collection of the Academy.

Aside from Mr. Binney's volumes, which contain merely descriptions of part of the species discussed below, the strongest paper dealing with them is Dr. V. Sterki's *Notes on Zonitidæ*.[8] The fact that *Zonites andrewsi* and the Eastern form commonly known as *significans* have few teeth or none when adult is set forth, and the author shrewdly suggests that these two forms may be the young of *Z. placentulus* and *capsella* respectively. Dr. Sterki worked from small series of specimens from a few localities, and with much more ample material it is easy now to criticise his solution of the difficult problem; but he saw further into the relationships of these forms than any writer up to that time. My former course in separating the species into two sections, one of which (*Taxeodonta*) was placed under *Gastrodonta*, was a step backward. No such arrangement would have been entertained had I examined the dentition. In *Gastrodonta* the lateral teeth are more numerous than in *Vitrea* or *Paravitrea*, and conspicuously different in shape.

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[7] These *Proceedings* for 1900, p. 145.

[8] *Nautilus*, VII, pp. 13–17, June, 1893. It may be as well to note here that the *Gastrodonta* described by him under No. 3 (p. 14) is what I described as *G. collisella*. His No. 6 (p. 15) is apparently *G. cœlaxis*.

Key to average or normal specimens of Paravitrea.

I.—Surface closely and regularly rib-striate or grooved, at least above; umbilicus minute.

a.—Diam. 5–6.5 mm.; spire flat or slightly convex, the suture deep; 6½ convex, narrow whorls, subregularly and deeply grooved radially, above and below. Umbilicus minute. No internal teeth, ... *V. clappi.*

a'.—Diam. 2.5 to 3.5 mm.; very closely rib-striate above; whorls 5½–6, closely coiled, the spire but slightly convex.

b.—One to three radial rows of 5 or 6 teeth each, visible through the base, ... *V. multidentata.*

b'.—One to three radial curved barriers, visible through the base; surface not striated spirally; width of umbilicus about one-tenth that of the shell, . . *V. lamellidens.*

b''.—With barriers like the preceding species, or none; surface finely striate, the striæ decussated by very minute spirals; umbilicus wider, its diameter contained about 5½ times in that of the shell, ... *V. walkeri.*

II.—Surface sculptured with spaced, unequal radial grooves, more conspicuous above.

a.—Diam. of adults 5 to 6 mm.; toothless or with teeth in pairs.

b.—Periphery median; aperture usually crescentic. Eastern forms.

c.—Shell toothless, ... *V. capsella.*

c'.—Shell with internal pairs of teeth, . *V. c. lacteodens.*

b'.—Western forms (Missouri, Arkansas, Indian Territory), with the aperture subtriangular.

c.—Young usually toothed; adults dome-shaped, with subbasal periphery, ... *V. significans.*

c'.—Not toothed; adults discoidal, . . . *V. simpsoni.*

a'.—Diam. of adults 7 to 7½ mm.; toothless or with 1 to 5 teeth in each row.

b.—No teeth at any stage of growth; *whorls 7 to 7½*, *V. placentula.*

b'.—Teeth developed in young shells, persisting or absent in adults; shell very fragile; *whorls 8 to 8½*, *V. andrewsæ.*

Vitrea clappi (Pils.). Pl. X, figs. 1, 1*a*, 1*b*, 8, 8*a*.

Gastrodonta clappi Pils., Nautilus, XII, p. 86 (December, 1898); XV, p. 37, Pl. 2, figs. 8, 9 (August, 1901); Proc. Acad. Nat. Sci. Phila., 1900, p. 144. Ferriss, Nautilus, XII, p. 99; XV, p. 58.

Range: Great Smoky Mountains, along the Tennessee-North Carolina boundary range from Thunderhead and Blockhouse Mountains to the Big Pigeon river.

The type locality is Miry Ridge. The type (Pl. X, figs. 1, 1*a*, 1*b*), with a diameter of 5.5 mm., has a minute umbilicus, about .2 mm. wide, and the spire of 7 whorls is convex. In all other specimens seen the

spire is lower, either flat or but slightly convex; and with one exception, all have the same minute umbilicus. In one specimen, from Clingman Dome, No. 2,490 of the collection of Mr. George H. Clapp (Pl. X, figs. 8, 8*a*), the umbilicus is decidedly larger, .6 mm. wide, the shell having a diameter of 6.2 mm., with 6½ whorls. Whether this is an individual variation or the representative of a race of more widely umbilicate shells, remains to be determined.

In 1900 Mr. Ferriss traced this beautiful and excessively rare species far to the northeast of the original locality, taking specimens at Mt LeConte, and at Indian Gap and Newfound Gap on the Big Pigeon river.

Vitrea lamellidens (Pils.). Pl. X, figs. 2, 3, 3*a*, 3*b*.

Gastrodonta lamellidens Pils., Nautilus, XI, p. 134 (April, 1898); Proc Acad. Nat. Sci. Phila., 1900, p. 145. Ferriss, Nautilus, XII, p. 99; XIV pp. 52, 58. Walker and Pilsbry, Proc. Acad. Nat. Sci. Phila., 1902, p. 437.

Range: Great Smoky Mountains, along the Tennessee-North Carolina boundary, from the Little Tennessee river to Thunderhead Mountain (the type locality), and eastward in Graham county, N. C.; also in the Black Mountain range at Bluff Mountain and Pinnacle of the Blue Ridge.

Similar to *V. multidentata*, but armed within with curved, obliquely radial barriers instead of rows of teeth, and having a narrower umbilicus, its width contained about 10 times in that of the shell, while in *multidentata* it is contained only about 6 times.

In about 150 individuals collected in 1899 and previously, which I examined, all had from one to three lamellæ; but a very large shell, diam 3.8 mm., found by Mr. Ferriss on Thunderhead in 1900, has no lamellæ whatever—a feature of senility. Even in the youngest individuals I have seen, such as Pl. X, fig. 2, diam. 1.4 mm., there are two or three barriers, though one would expect rows of teeth in so early a stage. Not one *V. multidentata* has yet been found with *lamellidens*, which lives mainly in the moist heights, where the mountains lift their heads into the clouds. We did not find it in the "coves" below.

Vitrea multidentata (Binney). Pl. X, figs. 6, 6*a*.

W. G. Binney, Man. Amer. Land Shells, p. 183 (1885).

The southernmost locality is Talassee Ford of the Little Tennessee river, whence Mr. Ferriss reports it.[9]

Figured for comparison with the preceding and following species With ordinary specimens of *multidentata* there sometimes occur shells in which radial barriers similar to those of *V. lamellidens* replace the

[9] Nautilus, XIV, 58.

teeth of the normal form. Such specimens are known from West Granby, Hartford county, Conn.; Garrettsville, O. (Pl. X, fig. 7); Greenwich, N. Y. (Acad. Coll.); Deering, N. H.; Litchfield, N. Y. (Coll. G. H. Clapp); Ottawa, Can. (Coll. Bryant Walker),[10] and Ithaca, N. Y. (Coll. H. E. Sargent). In the adult specimens I have seen, like that figured (diam. 3 mm.), the umbilicus is about as wide as in *multidentata*. In those examined by Mr. Clapp it is narrower, as in *lamellidens;* but his shells are not full grown, measuring only 2 to 2.5 mm. in diameter. From the occurrence of this form as rare single specimens, always with typical *multidentata*, I am still disposed to look on the specimens as accelerated individuals, sporadically occurring—the pioneers of a new race, further advanced in evolution than *multidentata*. If my view is correct, this race of the future will be parallel to *lamellidens*, which has in the past undergone a like transformation.

A view apparently much simpler is held by Mr. Clapp, who regards the Northern specimens with continuous barriers as really *V. lamellidens*, which in this view has an extensive range north to Canada.

Vitrea walkeri (Pilsbry). Pl. X, figs. 4, 4*a*, 5.

Gastrodonta walkeri Pils., Proc. Acad. Nat. Sci. Phila., 1900, p. 146. Ferriss, Nautilis, XIV, pp. 52, 58.

Range: Great Smoky Mountains, in Graham county, N. C., and Monroe county, Tenn.

This form is about the size of *V. multidentata*, ordinarily measuring about 2.9 mm., with 5½ to 5¾ whorls, and an umbilicus contained about 5½ times in the diameter of the shell, much as in *multidentata*. It is either toothless or has radial barriers of the *lamellidens* type, but the wider umbilicus and minutely decussate surface readily separate the species from *lamellidens*.

No specimens have turned up since our expedition of 1899, and it remains one of the rarest of land snails. Figs. 4, 4*a* represent a shell from Tuskeegee Mountain; fig. 5 a specimen from Talassee Ford of the Little Tennessee river.

Vitrea andrewsæ (W. G. Binney). Pl. XI, figs. 9, 9*a*, 10, 11, 11*a*, 11*b*.

Zonites andrewsi W. G. B., Ann. N. Y. Acad. Sci., I, p. 359, Pl. 15, fig. D (1879); [First] Supplement to Terr. Moll., V, p. 144, Pl. 2, fig. D (reprint from Ann. N. Y. Acad.); Man. Amer. Land Shells, p. 228, fig. 251. Sterki, Nautilus, VII, p. 16 (1893).

Gastrodonta andrewsæ W. G. B., Walker and Pilsbry, Moll. of Mt. Mitchell Region, N. C., in Proc. Acad. Nat. Sci. Phila., 1902, p. 437.

Range: Roan Mountain (type locality) to Paint Rock on the French Broad river, and eastward to the Black Mountains, N. C.

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[10] *Ottawa Naturalist*, XIV, p. 94, 1900. A single specimen of "lamellidens" with *multidentata*, collected by Gilbert Heron, is recorded by Mr. Walker.

Shell similar to *V. placentula* in general form and size, but the whorls increase more slowly, the last being narrower; thin and fragile, often sprinkled with buff dots. Teeth generally present, 3 to 5 being arranged in a radial row, or with several such rows within the basal wall, though the number of teeth may vary down to 0 in the adult stage, or less frequently at any stage of growth. Whorls 8 to 8½ in adults, which measure 7 to 8 mm. diam.

In some localities, as around Roan Mountain, teeth are almost invariably developed. In some other localities they are rare in adult shells, and developed in the young ones only. Such toothless individuals are separable from *V. placentula* by their slightly more fragile structure and greater number of narrower whorls.

In a multitude of shells examined from over a dozen localities, I found one young specimen with a diameter of 4 mm. in which there was a single radial barrier, such as occurs in *V. lamellidens* Pils.[11] The figures are from topotypes.

Vitrea placentula (Shuttleworth). Pl. XI, figs. 1, 1*a*, 1*b*.

Zon. placentulus Shuttl., Sterki, Nautilus, VII, p. 17 (1893).
Vitrea capsella placentula Shuttl., Pils., Proc. Acad. Nat. Sci. Phila., 1900, p. 140.

This species, if such it be, differs from *V. capsella* merely in the larger size, and in having an additional whorl. Adult shells measure 7 mm. diam., and have 7 or 7½ whorls. I have never seen a specimen with teeth, although a good many shells, adult and young, from the Great Smoky Mountains and elsewhere have passed under my lens; but when very young individuals of *placentula* are found, I think they will prove to have pairs of teeth, at least in rare cases, as in *capsella*. It is a trifle more solid than *V. andrewsæ* (W. G. B.), and in specimens of the same size the latter has a whorl more. The range of *V. placentula* lies to the southwest of that of *V. andrewsæ*. It was not taken by Ferriss and Walker in the valley of the French Broad river, nor in the Black mountains. Sterki's suggestion that *andrewsæ* is the young of *placentulus* is not borne out by the facts now known. Over a large part of the range of *placentula*, *V. andrewsæ* does not occur.

The figured specimen is from Philadelphia, Loudon county, Tenn.

Vitrea capsella (Gld.). Pl. XI, figs. 2, 3, 4, 4*a*, 4*b*.

Zonites capsella Gld., W. G. Binney, Man. Amer. Land Shells, p. 221.

The type locality of this species is "Tennessee." Two specimens

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[11] This specimen is No. 16,963 of Mr. Bryant Walker's collection, taken by him at Paint Rock, N. C., on the south side of the French Broad river, near the Tennessee boundary.

so labelled, presumably from the original lot, are in the collection of the Academy, given by Gould.

The species differs from *V. significans* chiefly in the different contour of the adult shell; from *V. placentula* in the smaller size of the adults. The shell measures from 5 to nearly 6 mm. in diam., and has 6 to 7 whorls. Rarely, a young individual may be found with a pair or two of internal teeth (Pl. XI, fig. 3, diam. 2 mm.), recalling the ancestral dentate stock; but this stage is now passed through at an early age, or entirely skipped; and in the series I have examined, from southwestern Virginia, Kentucky, Tennessee and Alabama, toothed individuals are very unusual.

V. capsella is not known from west of the Mississippi depression, being represented there by the very closely related *V. significans* and *V. simpsoni*. The figures represent specimens from Woodville, Ala., collected by Mr. H. E. Sargent.

Vitrea placentula and *significans* might, with no great violence, be subordinated to *capsella* as subspecies.

Vitrea capsella lacteodens n. v. Pl. XI, figs. 5, 5*a*.

Hyalina significans Bld., Harper, Journ. Cincinnati Society of Natural History, IV, 1881, p. 258, figs. 2, 2*a*.
Zonites significans Bld., Wetherby, Journ. Cin. Soc. N. H., IV, December, 1881, p. 328, No. 25. W. G. Binney, Man. Amer. Land Shells, p. 228, fig. 250 (exclusive of quotation from Bland, etc.). Sterki, Nautilus, VII, pp. 16, 17 (1893).
Gastrodonta significans Bld., Pilsbry, Moll. of the Great Smoky Mts., Proc. Acad. Nat. Sci. Phila., 1900, p. 147.
Vitrea capsella, specimens from Tuskeegee Mountain, Graham county, N. C., Pilsbry, *l. c.*, p. 140.

Type specimens from "Ramp Cove," Tuskeegee Mountain, N. C., taken by James H. Ferriss and H. E. Sargent, 1899.

The shell is similar to *V. capsella*, except that most specimens have one to three pairs of tubercular teeth within the last whorl. The sutures are a trifle less impressed, and the striation perceptibly closer. It differs from *V. significans* in the usual persistence of the teeth in the adult stage, and the median position of the periphery. In fully adult *significans* the periphery is subbasal, and there are no teeth.

Alt. 2.6, diam. 5 mm.; whorls 6½.

This particular race occurs, so far as I know, only in the mountains of southwestern North Carolina. It is not separable from *V. capsella* by any hard-and-fast character, but merely by the persistence of the pairs of teeth in most adult shells of any given lot. Thus in the type lot, collected by Mr. Sargent on Tuskeegee Mountain, Graham county, N. C., one adult out of thirteen before me is quite toothless, and by

itself would be called *capsella*. Some others have only one or two teeth remaining. It is the general character of the specimens from any one place, not the particular condition of each individual, that must be considered.

Harper, Wetherby, W. G. Binney and Sterki have mistaken this race for the Western *V. significans*, and I formerly followed this erroneous identification.

Vitrea significans (Bld.). Pl. XI, figs. 7, 7*a*, 7*b*, 8, 8*a*.

Helix significans Bld., Amer. Journ. of Conch., II, p. 372, Pl. 21, fig. 9 (not good).

Zonites significans Bld., Binney, *op. plur.*, exclusive of East Tennessee form.

Range: Originally described from Fort Gibson, Indian Territory, this species has been taken to my knowledge in Arkansas, at Mabelvale (C. W. Johnson[12]), and in southwestern Missouri, at Seligman, Barry county (Ferriss, 1901).

As Bland stated in his original description, the young shells are sometimes provided with one or two pairs of tubercular teeth within, visible through the base of the shell as white spots. The full-grown shells are toothless, more or less dome-shaped, the periphery being situated below the middle of the last whorl, the circumference of which is flattened and sloping. The base is very concave in the middle. This gives the shell a peculiar and unusual contour. Half-grown and young individuals are normal in shape, and very similar to *V. capsella* and its variety *lacteodens*, from which, indeed, it would be almost impossible to separate them except by the locality. The spire, seen from above, is about the same in *capsella*, *placentula* and *significans*. Figs. 7, 7*a*, 7*b* represent fully adult specimens of the typical form from Seligman, Barry county, Mo., collected by Mr. Ferriss; figs. 8, 8*a* are immature shells from the same place and lot.

Vitrea simpsoni (Pilsbry). Pl. XI, figs. 6, 6*a*, 6*b*.

Zonites capsella Gld., Simpson, Proc. U. S. Nat. Mus. for 1888, p. 452.

Zonites simpsoni Pils., These Proceedings for 1889, p. 412, Pl. 12, figs. 8–10.

Vitrea simpsoni Pils., These Proceedings for 1900, p. 456; Ferriss, Nautilus, XIV, pp. 30, 31.

Range: Western Arkansas and Indian Territory; Mena and Hatton's Gap, Polk county, in western, Morris Ferry, Little River county, southwestern Arkansas (J. H. Ferriss); Limestone Gap, I. T. (C. T. Simpson).

This species is more depressed than *significans* or *capsella*, with *the last whorl decidedly wider*, when viewed from above. It has not yet

[12] Reported in the *Catalogue of Land Shells*, 1898, p. 26, under *V. simpsoni*, No. 275.

been found with teeth, but so far only small numbers have been taken. The type is figured.

Zonitoides minusculus (Binn.).

Seligman, Barry county, Mo.

Zonitoides arboreus (Say).

Poteau, Tushkahoma, and Antlers, I. T.; Seligman, Mo.

Gastrodonta demissa (Binney).

Carrion Crow Mountain, Pope county, Ark. Twenty-one specimens, most of them narrowly perforate, with a very heavy internal callus; four have a low lamella, and one is imperforate. They therefore unite characters of the varieties *lamellata* and *brittsi*, like those from other places in their same general region. Cf. these *Proceedings* for 1900, p. 456.

At Hot Springs, Garland county, Ark., *G. demissa brittsi* was taken, a few of the specimens having an internal lamina.

Various forms of *demissa* were taken at Poteau* and Tushkahoma,* I. T., and Rich Mountain,* Ark., reported by Mr. Ferriss.

ENDODONTIDÆ.

Pyramidula solitaria (Say).

Reported from Rich Mountain, Polk county, Ark., by Mr. Ferriss.

Pyramidula alternata (Say).

Typical specimens at Petit Jean, Yell county, Ark., and Seligman, Mo., and Standley, Choctaw Nation, I. T. Also reported by Ferriss from Rich Mountain and Hot Springs, Ark.

Pyramidula perspectiva (Say).

Reported by Ferriss from Seligman, Mo.; Petit Jean and Rich Mountain, Ark.

Helicodiscus lineatus (Say).

Seligman, Barry county, Mo.

SUCCINEIDÆ.

Succinea avara Say.

Seligman, Mo.; Rich Mountain, Ark.

LIMNÆIDÆ.

Limnæa columella Say.

Winding Stair Mountain, I. T.

Explanation of Plates IX, X, XI.

Plate IX, Figs. 1, 2, 3.—*Polygyra pilsbryi* Ferriss. Topotype.

Figs. 4, 5, 6.—*Polygyra blandiana* Pils. (*Helix labrosa* Bland, not Wood). Type. Petit Jean Mountains, Yell county, Ark.

Fig. 7.—*Polygyra uncifera* Pils. Cotype. Mena, Polk county, Ark.

Figs. 8, 9, 10.—*Polygyra uncifera* Pils. Rich Mountain, Polk county, Ark.

Figs. 11, 12, 13.—*Polygyra blandiana* Pils. Cotype. Springfield, Green county, Mo.

Plate X, Figs. 1, 1*a*, 1*b*.—*Vitrea clappi* Pils. Three views of the type. Miry Ridge, Great Smoky Mountains.

Fig. 2.—*Vitrea lamellidens* Pils. Young individual from Thunderhead, diam. 1.4 mm. No. 77,752 A. N. S. P.

Figs. 3, 3*a*, 3*b*.—*V. lamellidens*. Thunderhead. Diam. 3.5 mm. No. 77,752 A. N. S. P.

Figs. 4, 4*a*.—*V. walkeri* Pils. Front and basal views of the type.

Fig. 5.—*Vitrea walkeri* Pils. Base of shell from Talassee Ford. No. 77,703 A. N. S. P.

Fig. 6, 6*a*.—*Vitrea multidentata* Binn. Basal and front views of a typical specimen from West Granby, Hartford county, Conn. No. 57,104 A. N. S. P.

Fig. 7.—*Vitrea multidentata* Binn. Base of a specimen with the teeth united into an even barrier. Garrettsville, O. No. 66,858 A. N. S. P.

Figs. 8, 8*a*.—*Vitrea clappi* Pils. Openly umbilicate specimen from Clingman Dome. No. 2,490 Coll. G. H. Clapp.

Plate XI, Figs. 1, 1*a*, 1*b*.—*Vitrea placentula* Shuttl. Philadelphia, Loudon county, Tenn. No. 5,490 A. N. S. P.

Fig. 2.—*Vitrea capsella* Gld. Half-grown shell, diam. 3 mm. Woodville, Ala. No. 68,820 A. N. S. P.

Fig. 3.—*Vitrea capsella* Gld. Young specimen with two pairs of internal teeth, diam. 2 mm. Woodville, Ala. No. 68,820.

Figs. 4, 4*a*, 4*b*.—*Vitrea capsella* Gld. Adult from Woodville, Ala., diam. 4.5 mm. No. 68,820 A. N. S. P.

Figs. 5, 5*a*.—*Vitrea capsella lacteodens* Pils. Tuskeegee Mountain, Graham county, N. C., No. 77,798 A. N. S. P.

Figs. 6, 6*a*, 6*b*.—*Vitrea simpsoni* Pils. Type. Limestone Gap, I. T. No. 61,676 A. N. S. P.

Figs. 7, 7*a*, 7*b*.—*Vitrea significans* Bld. A fully adult specimen from Seligman, southwestern Missouri. No. 81,446 A. N. S. P.

Figs. 8, 8*a*.—*Vitrea significans* Bld. Young shell with internal teeth, diam. 3.8 mm. Same locality.

Figs. 9, 9*a*.—*Vitrea andrewsæ* W. G. B. Half-grown shell from Roan Mountain, N. C., diam. 4.5 mm.

Fig. 10.—*Vitrea andrewsæ* W. G. B. Younger shell, diam. 3 mm.

Figs. 11, 11*a*, 11*b*.—*Vitrea andrewsæ* W. G. B. Adult, Roan Mountain, N. C. No. 67,577 A. N. S. P. This and figs. 9, 9*a* and 10 are from specimens of the original lot, collected by Mrs. George Andrews.

A REVISION OF THE NORTH AMERICAN ANTS OF THE GENUS LEPTOTHORAX Mayr.[1]

BY WILLIAM MORTON WHEELER.

The diminutive species of the cosmopolitan genus *Leptothorax* are among the most interesting though least conspicuous of our ants. No other group of Formicidæ appears to present such diversity of habits, while at the same time adhering so closely to certain rather definite generic peculiarities. The species all form small colonies, often of not more than twenty-five to fifty individuals, and occupy small cavities in the soil, or between stones, or in the tissues of plants. These cavities are either of their own excavation, or found ready to their use in the form of accidental openings or the burrows and galleries of larvæ, other ants, etc. Favorite nesting-places are the abandoned woody galls of the Cynipidæ, like the galls of *Holcaspis cinerosus* on the live-oaks of central Texas, the galls of Diptera, like *Trypeta solidaginis* on the golden-rod, etc. Even hollow nuts on the ground under the trees are sometimes tenanted by species of *Leptothorax*. Brief notes on the nesting habits, so far as these are known, are appended to the descriptions of the different species enumerated below.

The small size and obscure location of the *Leptothorax* nests, which form a remarkable contrast with the teeming, conspicuous formicaries of other ants like *Formica rufa*, *F. exsectoides*, *Pogonomyrmex barbatus* and *Ischnomyrmex Cockerelli*, will readily account for our rather limited knowledge of the North American species. Then, too, none of our *Leptothorax* are really common, except in certain circumscribed localities, so that the discovery of the species is more often a matter of accident than of deliberate search, even when one is out looking for ants and nothing else. Single workers are found running about on the ground or on the trunks and branches of trees in search of sweet exudations, small insects or the remains of large insects that have been rejected by spiders, birds, etc. The nests are most readily found by following up such single workers, often a tedious and time-consuming task, as these insects will sometimes run about for an hour or

[1] Contributions from the Zoological Laboratory of the University of Texas, No. 48.

more in search of food before returning to the nest and revealing its hidden entrance, a tiny hole like a pin-prick in the soil or bark.

None of the species are known to attend aphides, and the nests very rarely or never contain guests or synœketes of any description. The *Leptothorax* themselves, however, sometimes live as guests in the nests of larger ants. Thus *L. Emersoni* is always found as a guest in the nests of *Myrmica brevinodis*, and *L. acervorum* of Europe and its American variety *convivialis* also exhibit a decided tendency toward xenobiosis. The typical *L. curvispinosus* appears to act as the slave of *Tomognathus americanus*, an extremely rare ant, which is probably similar in habits to its European congener, *T. sublævis*. Most of the species of *Leptothorax* are very timid, and many of them readily "feign death" when roughly handled. Nevertheless they are often extremely hostile and vindictive toward other ants, especially toward ants of their own species from strange nests.

For our first insight into the habits of *Leptothorax* we are indebted to Forel, who recorded his observations in the charming *Fourmis de la Suisse* (pp. 339–341). The more important of these observations are given in the following translation:

"April 17, 1868, I found in the bark of a pine-tree a very small colony of *L. tubero-affinis*, consisting of a fertile female, about a dozen workers and some eggs. I lost four of the workers during the capture and broke two of the legs of the female. I subsequently placed this little family in a pasteboard box with a glass cover. It prospered; the female got on well with her four remaining legs; some of the eggs hatched and the larvæ were fed. The workers would eat nothing but the honey which I gave them; they were very timid and settled down with the female in the box. They gave little heed to the female, which lived almost like them. I have noticed that it is only the workers of the genera *Plagiolepis* and *Lasius* and of certain species of *Formica* that assiduously court their fertile females. *Leptothorax* goes to the opposite extreme: the females live almost like the workers, being merely somewhat less inclined to work. Huber was wrong, therefore, in generalizing the rôle of the fertile females of *Lasius*, etc. By May 24 the female of my captive formicary had again laid some eggs, and the larvæ had grown very large. The workers ate larvæ of *Lasius* that were given to them. June 4 one of the larvæ became a worker pupa, but there remained only two large larvæ and the eggs. June 10 there were two pupæ and eight or nine small larvæ had hatched from the eggs. Of the latter two were yellow and retained this color, the others were whitish. By June 13 they had grown. I then gave my *L.*

tubero-affinis a worker pupa of *L. Nylanderi*, and they took care of it. These ants never attempted to escape when I opened the box. They impressed me by the delicacy of the sense of touch in their antennæ, as they felt of little particles with remarkable precision and distinguished their qualities (one of the eggs of their queen, a grain of dust, a particle of honey, etc.). June 21 I gave them some pupæ of *Tetramorum cæspitum* which they killed and ate. On June 25 *the pupa of L. Nylanderi had hatched, and the resulting worker lived on good terms with the tubero-affinis*, working with them. June 28 I lost several workers through carelessness; there remained only the queen with five worker *tubero-affinis* and the worker *Nylanderi;* the small larvæ had grown considerably and began to pupate. June 29 one of the older pupæ hatched and the other soon followed, so that two worker *tubero-affinis* were added to the colony. The same day I gave my ants worker pupæ of *T. cæspitum.* They cared for two or three of the younger ones and killed the others which were about to hatch, or rather allowed them to die through neglect. July 15 three more small larvæ made their appearance. July 16 *one of the two pupæ of T. cæspitum, which they had continued to foster, hatched and lived thenceforth with these ants of a different genus, on the best of terms.* July 18 the second pupa of *T. cæspitum* followed suit, but this worker was somewhat malformed and died in a week. The first *Tetramorium,* on the contrary, prospered apace; it was larger than any of the *Leptothorax* workers and was conspicuous on account of its activity. It ran about continually in all parts of the box, but kept returning from time to time to the *Leptothorax.* By July 29 a fresh batch of little *tubero-affinis* larvæ had grown up, and the pupæ of the second generation began to hatch. August 16 I placed the seven surviving *tubero-affinis* workers and their queen in alcohol, as the colony had suffered considerably during my trip from Zurich to Vaux. It had lived in captivity four months. . . . .

"June 25, 1868, having found a formicary of *L. acervorum* in the bark of a pine, with a winged female and some female pupæ, I captured and preserved it in a box till August 16. Several females hatched in the box. The females of this species are not larger than the workers. I often saw these little females carrying the larvæ and pupæ about like the workers. Strange to say, nearly all of them lost their wings within two or three days from the time of hatching. I even saw one of them obviously endeavoring to rid herself of her wings by twisting them about. As they were born in a box containing no males, they could not have been fecundated. Hence I cannot conceive why they removed their wings. Can it be that the formicaries of *Leptothorax*

are kept up in this way, because the workers cannot retain the fertile females in the nests by force, on account of the small size of the nests and their position on vertical walls, or because the males may not often be present simultaneously with the winged females? Would not these deälated females be fecundated later by males appearing in the same formicary? The fact remains that one often finds in *Leptothorax* nests deälated females with small abdomens and apparently not fecundated, together with others obviously fertile. I refrain from deciding the question."

The questions asked by Forel so long ago still remain unanswered, although it is clear that the colonies are not as a rule renewed and maintained by a retention of the virgin females in the parental nest. My own observations show that the little colonies of these ants are founded by single fertile females, in the very same manner as the huge formicaries of *Formica, Camponotus*, etc. On several occasions I have found deälated females of *Leptothorax* either alone or with a very few eggs, larvæ or pupæ in isolated oak-galls (*e.g., L. obturator* q. v.). Moreover, I have never found more than one queen in a nest in any of the species that I have taken, except at the very height of the breeding season (May and early June in Texas, mid- or late summer in the Northern States). Although in such nests I have sometimes seen several deälated females, which probably arose as Forel has described, I am inclined to believe that all of these, except the mother queen, must soon leave the nest and establish colonies of their own.

The question naturally suggests itself: Why are the colonies of *Leptothorax* so small? I believe that this peculiar condition may be traced, in part at least, to the following causes, either singly or collectively: 1. The females are but little larger than the workers (in *L. Emersoni* they are not even larger than the workers) and this means relatively small fecundity. This appears to be the case also in other ants that have females of the same or nearly the same size as the workers (*Myrmecina, Stenamma s. str.;* Ponerinæ). And reciprocally, owing to this reduced fecundity, the queen cannot be abundantly fed, since she produces but few workers. 2. The workers of *Leptothorax* are probably short-lived as compared with many other ants. At least one is inclined to believe this from the rather high mortality among these insects in artificial nests. 3. In most species of *Leptothorax* each colony contains only a single fertile queen.[2]

[2] Other observations on the habits of *Leptothorax* will be found in the following works: Adlerz, "Myrmecologiska Studier," II. Svenska Myror och deras Lefnadsförhollanden, *Bihang till K. Svenska Vet. Akad. Handl.*, Bd. XI, No. 18,

The geographical distribution of the North American *Leptothorax*, though very incompletely known, is not altogether devoid of interest. So far as it is possible to generalize from existing data, it would seem that the species are rather uniformly distributed over the entire continent, not excepting at least a portion of the Arctic regions. By this I do not mean to say that the same species occur everywhere, or even that the distribution of a particular species is very wide, but that the ant-fauna of any given locality usually comprises a few species of *Leptothorax*. This indicates a wide range of adaptability to differences of soil, moisture, temperature, vegetation, etc., within the same genus. The extremes of this adaptation seem to be represented by forms like *L. curvispinosus*, which inhabits the humid shady woods of the North Atlantic States, and *L. Pergandei*, which occurs even on the sun-scorched soil of the Trans-Pecos deserts.

We have few species in common with Europe, probably only *L. acervorum* and *L. muscorum*, both presenting distinct American varieties or subspecies analogous to and occurring over the same territory as the American forms of *Formica fusca, rufa* and *sanguinea* and *Myrmica rubra*. All of these forms occur far to the north and to considerable altitudes, both in Europe and America, and undoubtedly constitute important elements of an ancient palæarctic ant-fauna.[3] At low altitudes and within our territory the forms of *L. acervorum* and *muscorum* seem to be confined to the northernmost tier of States.

The twenty species of *Leptothorax* recognized in the present paper as occurring in America north of Mexico are about equally distributed between the two divisions of the genus, which are characterized respectively by the workers and females having 11- (the males 12-) jointed antennæ, and the workers and females having 12- (the males 13-) jointed antennæ. It is an interesting fact that the species with 11-jointed antennæ in the workers are mainly confined to the Northern and Eastern States, those with 12-jointed antennæ to the Western and Southwestern territory. Exceptions are *L. curvispinosus* and *acervorum*, which present varieties even in New Mexico (though at considerable altitudes!) and *L. tricarinatus*, which was described from South

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1886, and III. Tomognathus sublævis Mayr, *ibid.*, Bd. XXI, No. 4, 1896; Wheeler, "The Compound and Mixed Nests of American Ants," *Am. Natural.*, Vol. XXXV, Nos. 414, 415, 417 and 418, 1901, and "Ethological Observations on an American Ant (*Leptothorax Emersoni* Wheeler)," *Arch. f. Psych. u. Neurol.*, Bd. II, Heft 1 u. 2, 1903 pp. 1–31.

[3] *L. acervorum* var. *convivialis* (q. v.) has been taken on the summit of Las Vegas Range, N. M., at an altitude of 11,000 feet, by Prof. T. D. A. Cockerell in xenobiosis with another boreal ant, *Myrmica brevinodis*. *L. acervorum* var. *Kincaidi* was described by Pergande from Alaska.

Dakota. All the new species described in the present paper belong to the group with 12-jointed antennæ, and it is probable that many more members of this group remain to be discovered in the West and Southwest. Both groups are represented in Mexico and Central America. To judge from Emery's table of the South American species, those with 11-jointed antennæ predominate again south of the Equator. Most of these species, however, whether having 11- or 12-jointed antennæ, have acute, projecting angles to the pronotum, and are therefore consigned to a particular subgenus, *Goniothorax*, by Emery.[4] The small group comprising the subgenus *Dichothorax* Emery (possibly monotypic) is confined to the Southern United States. This subgenus resembles the subgenus *Temnothorax* Mayr (including only *T. recedens* Nyl.) in many respects. It is interesting to note that this form occurs only in Southern Europe.

While some of the European *Leptothorax* (like *tuberum* and *unifasciatus*) are known to be extremely variable, the North American materials at the disposal of previous writers have not been sufficient to prove the same for any of the species on this side of the Atlantic. Nor am I able to throw as much light as I could wish on the limits of variability in our species, although my material certainly shows that some of our species are decidedly unstable. Such are, *e.g.*, *L. acervorum*, *curvispinosus*, *nitens* and possibly also *Schaumi* and *fortinodis*, especially if the two latter really represent extreme forms of the same species, as seems to be indicated by the existence of intermediate forms.

The genus *Leptothorax* was established by Mayr in 1855,[5] on a number of species previously included by Nylander and other myrmecologists in the composite genus *Myrmica*, a genus which at one time contained practically all the known ants of the subfamily Myrmicinæ. Though some of the characters of *Leptothorax* are not very definite, the genus has nevertheless stood the test of nearly half a century and will probably continue to stand. Like many ant-genera, and genera of other animals also, for that matter, it is recognized not so much by a description of its characters, as by its peculiar and almost unmistakable habitus. He who has had little experience in handling ants will be liable to confound the workers of *Leptothorax* with the workers of *Pheidole* or *vice versa*, but to the experienced eye even the gait of the

[4] "Studi sulle Formiche della Fauna Neotropica," *Bull. Soc. Ent. Ital. Ann.*, XXVIII, 1896, pp. 26, 27.

[5] "Formicina Austriaca," *Verh. K. K. zool.-bot. Ver. Wien*, Bd. 5, 1855, pp 431–433.

ants of these two genera differs very decidedly. The following are the leading diagnostic characters of the genus *Leptothorax*.

LEPTOTHORAX Mayr.

Worker.—Small, monomorphic. Head longer than broad, and broader than the thorax. Mandibles broad, 4–5-toothed. Maxillary palpi 5-jointed; labial palpi 3-jointed. Clypeus variable in shape, slightly convex or impressed in the middle, its anterior border somewhat rounded, entire or sinuately excised in the middle. Frontal carinæ almost straight, diverging very little behind. Antennæ 11- or 12-jointed, usually with a distinctly 3-jointed club. Frontal area present. Eyes of moderate size, near the middle of the lateral surface of the head. Ocelli occasionally present, especially in ergatoid or subergatoid individuals. Thorax slender, usually somewhat broader in front, at least above, and narrower behind. Promesonotal suture obsolete; mesoëpinotal suture present or absent, the thorax at this region either without any constriction, with a faint or a very decided (subgen. *Dichothorax*) constriction. Epinotum armed with a pair of teeth, or spines of variable development. Petiole with a short peduncle in front and surmounted by a node of variable form, its lower anterior surface armed with a median tooth. Postpetiole nodiform, sometimes more campanulate, unarmed below. Gaster large, broadly elliptical, compressed dorsoventrally, its basal three-fourths formed by the first segment. Sting well developed, at least in many of the species. Legs rather stout, the femora fusiform, somewhat incrassated in the middle, the tibiæ thicker toward their distal ends. Spurs of middle and hind legs simple, not pectinate. Integument very hard. In most species the hairs on the body, and in a few also those on the appendages, are short, erect, clavate and under a high magnification finely crenulate. Our species are yellow, brown, red or black, and the majority of them have the head, thorax and pedicel more or less sculptured and in great part opaque. The gaster in all our species is very smooth and shining.

Female.—Somewhat larger and more robust than the worker, or of the same size. Antennæ of the same number of joints. Eyes and ocelli moderately prominent. Thorax with its sides subparallel or somewhat bulging in the middle. Mesonotum conspicuously flattened. Epinotal spines shorter and often stouter than in the worker. Basal surface of epinotum nearly horizontal. Petiole and postpetiole like the corresponding segments of the worker, the node of the former often more acute. Gaster like that of the worker, at least its basal two-

thirds formed by the first segment. Wings milky or yellowish hyaline, with very pale and indistinct veins and stigma. Radial cell sometimes open, sometimes closed. There is a single cubital cell. Transverse vein meeting cubital vein at its bifurcation; internal cubital often indistinct. Discal cell closed. The pilosity of the female is usually less pronounced than that of the worker, though of the same character; the sculpturing is rougher.

Male.—Of the same size as the worker, or but little larger, and usually darker in color. Head short and as broad or broader than the thorax. Mandibles variable, narrow, truncate and toothless, or dentate or denticulate. Clypeus somewhat convex. Antennæ 12–13-jointed; scape short, funiculus very long, slightly thickened at its distal end to form, in many cases, an indistinct 4-jointed club. Eyes and ocelli large and prominent. Mayrian furrows of mesonotum very distinct. Epinotum not prolonged backward, with two small swellings, rarely with two short teeth, in the place of the worker armature. Petiole more slender and with lower node than in the worker. Postpetiole nodiform or subcampanulate. Gaster rather slender, elongate elliptical, often slightly flattened dorsoventrally. Legs slender. Wings as in the female. Hairs on the body and appendages usually much less conspicuous than in the worker, not clavate.

I subjoin a table for the identification of the workers of the various *Leptothorax* species known to occur in America north of Mexico. As the females of only half and the males of less than half of our species are known, it is hardly worth while to construct tables for the identification of the winged sexes.[6]

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[6] The following species have been described from Mexico and Central America, and in all probability comprise but a very small portion of the species actually occurring in these countries:

1. *Leptothorax Stolli* Forel, Bull. Soc. Vaud. Sci. Nat. (2). XX, p. 352, 1894. ♂ ☿; Dalla Torre, Cat. Hymenopt., VII, 1893, p. 127; Forel, Biol. Centr. Am., III, 1899, p 54. ♀.
   Guatemala, summit of crater of the Volcan de Agua (13,000 feet!); living under stones.
2. *L. echinatinodis* Forel, Compt. Rend. Soc. Ent. Belg., XXX, 1886, p. xlviii. ☿; Biol. Centr. Am., III, 1899, p. 55.
   Rio Janeiro, Brazil. Lives in hollow twigs. The typical form has not been found in North America, but only the following subspecies and possibly its variety:
   Subsp. *aculeatinodis* Emery, Bull. Soc. Ent. Ital., XXVIII, 1896, p. 60. ☿.
   Costa Rica, Jimenez. Also Brazil.
   Var. *pungentinodis* Emery, Bull. Mus. Zool. Torino, XI, 1896, p. 2. ♀.
   Mexico, Atoyac en Vera Cruz; Panama.
3. *L. Pittieri* Forel, Biol. Centr. Am., III, 1899, p. 56. ☿. Costa Rica.
4. *L. Tristani* Emery, Bull. Soc. Ent. Ital., XXVIII, 1896, p. 61. ☿♀. Forel, Biol. Centr. Am., III, 1899, p. 56 Jimenez, Costa Rica.

Table for the identification of the workers of Leptothorax.

1. Antennæ 11-jointed, ... 2
   Antennæ 12-jointed, ... 10
2. Thorax with faint but distinct mesoëpinotal constriction, ... 3
   Thorax without mesoëpinotal constriction, ... 7
3. Postpetiole sculptured, opaque, ... 4
   Postpetiole smooth and shining above, ... 6
4. Tibiæ and antennal scape without clavate hairs, ... 5
   Tibiæ and antennal scape with short, erect, clavate hairs, *L. hirticornis* Emery.
5. Hairs on body long and thin, not clavate, *muscorum* Nyl. var. *sordidus* var. nov.
   Hairs on body short and clavate, *acervorum* Mayr. subsp. *canadensis* Prov., etc.
6. Tibiæ with clavate hairs, ... *Provancheri* Emery.
   Tibiæ without clavate hairs, ... *Emersoni* Wheeler.
7. Epinotal spines very short, dentiform, ... 8
   Epinotal spines long, ... 9
8. Petiole not conspicuously larger in profile than the postpetiole, *Schaumi* Roger.
   Petiole conspicuously larger in profile than the postpetiole, *fortinodis* Mayr. (and its varieties).
9. Dark-colored, with very long, horizontal epinotal spines, *longispinosus* Roger.
   Yellow, sometimes more or less infuscated; epinotal spines shorter, *curvispinosus* Mayr. (and its subspecies and varieties).
10. Without mesoëpinotal constriction; hairs on body clavate, not abundant, 11
    With pronounced mesoëpinotal constriction, hairs abundant, not clavate (subgenus *Dichothorax* Emery), ... 19
11 Head very largely smooth and shining, ... 12
    Head opaque or subopaque, or smooth only along the median line or behind, ... 13
12. Very dark-brown, or black, antennal scape almost reaching the posterior angle of the head, ... *Schmittii* sp. nov.
    Yellow, or somewhat infuscated; scape reaching to ⅔ the distance between the eye and the posterior corner of the head, ... *nitens* Emery (and its subspecies and variety).
13. Anterior margin of clypeus entire, rounded, ... 14
    Anterior margin of clypeus sinuately excised, ... 16
14. Head and thorax very coarsely reticulate-rugose, . . . *texanus* sp. nov.
    Head and thorax not coarsely reticulate-rugose, ... 15
15. Clypeus produced, with angularly projecting anterior border, *tricarinatus* Emery.
    Clypeus not produced, with broadly rounded anterior border, *neomexicanus* sp. nov.
16. Black or dark-brown species, ... 17
    Yellow species, ... 18

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5. *L. petiolatus* Forel, Ann. Soc. Ent. Belg., XLV, 1901, p. 129. ☿. Wheeler, Ann. Soc. Ent. Belg., XLV, 1901, p. 201.

Cuernavaca, Mexico. "A single nest, consisting of a deälated queen and about 25 workers in a Tillandsia in parabiosis with *Cryptocerus* and *Cremastogaster*."

17. Petiole slender, seen from above three times as long as broad, node very low and rounded, ... *obturator* sp. nov.
    Petiole only 1½ times as long as broad; node higher and shorter, *nevadensis* sp. nov.
18. Head opaque throughout, petiolar node round in profile; length 1.5–1.75 mm., *terrigena* sp. nov.
    Head with a smooth median line, node of petiole somewhat angular; length 2.25, ... *Andrei* Emery.
19. Summit of petiolar node seen from behind impressed or concave, *Pergandei* Emery.
    Summit of petiolar node seen from behind convex, rounded, *floridanus* Emery.

1. Leptothorax hirticornis Emery.

L. hirticornis Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, pp. 317 and 319. ☿.

Worker.—Length 2.75 mm.

Clypeus hardly impressed in the middle. Antennæ 11-jointed, joints 2–7 of the funiculus shorter than broad, club but relatively little thickened. Thorax slender, distinctly impressed at the mesoëpinotal suture. Epinotal spines of average size, pointed, strongly compressed. Petiole robust, its anterior and posterior dorsal slopes forming a slightly obtuse angle; seen from above the sides of the petiole are subparallel. Postpetiole small, almost trapezoidal, a little broader than long.

Clypeus somewhat shining. Head, thorax and pedicel opaque, densely foveolate-punctate, the upper surface of the head also finely and rather regularly longitudinally rugose.

Hairs very short, strongly clavate, erect, not only covering the body but also the antennal scape and legs.

Bright testaceo-ferruginous, gaster and middle of front infuscated.

Type locality: Washington., D C. (Pergande).

Described from a single specimen in the collection of Prof. Emery.

2. Leptothorax muscorum Nylander, var. sordidus var. nov.

L. muscorum Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, p. 318. ☿.

Worker (Pl. XII, fig. 2).—Length 2–2.75 mm.

Clypeus not impressed in the middle, its anterior border nearly straight, not produced. Antennæ 11-jointed; scape reaching to midway between the eye and the posterior angle of the head; first funicular joint as long as joints 2–4 together, terminal joint as long as the two preceding joints of the club. Thorax broad in front, with rounded humeri, much narrower behind, with a distinct mesoëpinotal constriction. Epinotal spines of moderate length, directed backward, and slightly outward, about as far apart at their bases as they are long. Petiole from above suboblong, with slightly convex sides, nearly

...he anterior and posterior slopes of ...h, the former slightly concave, the ... somewhat flattened. Postpetiole ... the petiole, but half again as broad, ...r angles and convex node.

...lly reticulate rugose, mandibles and ...h several longitudinal rugæ, which are ...ce shining. Thorax subopaque, irregu- ...ially on the pronotum and epinotum, ... delicately reticulate. Petiole and post- ...y reticulate rugose. Gaster smooth and

...unk whitish, rigid and obtuse, but hardly ...onspicuous on the abdomen. Antennæ and ... appressed, whitish hairs.

...d, except the mandibles, dark-brown. There ... on the pronotum and one on the epinotum. ...stpetiole, trochanters, swollen portions of the ...s and the dorsal surface of the gaster distinctly

...ulder, Colo.

...dozen specimens received from Rev. P. J. Schmitt,

...ears to be identical with the form mentioned by ...ity, S. Dak. (Pergande). It differs from specimens ...uropean *muscorum*, sent me by Prof. Forel from the ...Switzerland, in the following points: Hairs on the ...y shorter and at least on the head, thorax and pedicel ...ker. Dorsal portions of thorax and pedicel and the ...ions of the femora infuscated. These characters are **twelve** Colorado specimens.

...**rorum** Mayr, subs. **canadensis** Provancher.

... Provancher. Addit. Faun. Canada, Hyménopt., 1887, p ...7.

... **var.** *canadensis* Er. André, Rev. d'Entomol., VI, 1887, p.

... **var.** *canadensis* Dalla Torre, Catal. Hymenopt., VII, 1893,

... Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, pp. 317,

...I, fig. 4).—Length 2.75–3.5 mm.

...casionally present. Clypeus with a distinct longi- ...in the middle, its anterior border rather convex and

rounded. Antennæ 11-jointed; scape reaching midway between the eye and the posterior angle of the head; first funicular joint not longer than joints 2–3 together; terminal joint distinctly longer than the two preceding joints of the club. Thorax long, subcylindrical, somewhat narrowed behind, dorsally flattened, its anterior angles rounded; promesonotal and mesoëpinotal sutures both distinct, a slight but distinct constriction at the latter. Epinotal spines rather short and blunt, compressed, in many specimens tooth-like and hardly longer than broad at the base, directed backward in a line with the dorsal surface of the epinotum, in no case longer than their distance apart at the base. Petiole from above oblong, not more than 1½ times as long as broad, the node in profile with evenly concave anterior and somewhat depressed but convex posterior slope. Postpetiole trapezoidal, distinctly broader than long, its anterior angles prominent, anterior border distinctly broader than the posterior, dorsal surface hemispherical in profile.

Mandibles shining, coarsely punctate. Median impressed surface of clypeus smooth and shining, lateral surfaces longitudinally rugose. Head opaque, longitudinally reticulate rugose, the rugæ being most distinctly longitudinal on the front, vertex and cheeks. Thorax opaque, covered with reticulate rugæ which have a decidedly longitudinal trend on the dorsal and lateral surfaces of the pronotum and on the dorsal surface of the epinotum and the mesopleuræ. On the mesonotum the reticulation resolves itself into an area of even, close-set foveolæ. Pedicel opaque, the petiole sculptured like the mesonotum, the postpetiole somewhat smoother and almost punctate. Gaster smooth and shining.

Hairs whitish; those on the head, thorax and pedicel short, rigid and subclavate, on the gaster longer and thinner; on the antennæ and legs delicate, appressed.

Color dark-brown, almost black; small joints of the funiculus, the metatarsi, bases of femora, trochanters, ventral surface of pedicel, and in many specimens also the sutural regions of the thorax, yellow or pale-brown. In some specimens (immature?) nearly the whole thorax and the whole of the tibiæ are yellow.

Female (deälated).—Length 3.75–4 mm.

Apart from the distinctively sexual characters, the female differs from the worker in the following characters: The reticulate rugosity of the head is more decidedly longitudinal, the rugæ running back regularly to the occiput without deviation at the ocellar region. Mesonotum, scutellum and pleuræ traversed by distinct longitudinal rugæ

the first somewhat shining in the middle near its anterior border and in the regions of the parapsidal furrows. On the epinotum, about the bases of the spines, the rugæ become very coarse and reticulate. Epinotal spines short and blunt, resembling those of the worker in shape and direction. Petiolar node pointed, with rather flat anterior and posterior slopes, coarsely reticulate rugose. Sculpture of postpetiole less pronounced than that of the petiole, but coarser than the petiole of the worker. Pilosity short, like that of the worker, but the hairs on the head, thorax and pedicel are less clavate. Head, thorax, abdomen, femora and antennal club, black, remaining portions of the legs and the funicle, brown.

Type locality: "Canada."

Additional localities: Elk county, Pa. (Bradley); Olympia, Wash. (Kincaid).

This form should, I believe, be regarded as belonging to the same species as the European *acervorum*, as suggested by André. As Emery claimed, however, it deserves to rank as a subspecies, and not as a variety. The workers differ from the European specimens of *acervorum* in my collection (from Switzerland (Forel) and Scotland (Duglich)) in the shorter epinotal spines, the much deeper coloration of the thorax, pedicel and legs, the shorter and more clavate hairs on the trunk and the minute, appressed, instead of suberect hairs on the antennal scapes and legs. My specimens of the North American form average nearly as large as the European.

This subspecies is certainly rare in the Eastern States, but seems to be very common in Washington, to judge from the number of different nests sent me from that state by Prof. Kincaid. This is probably significant in connection with the palearctic distribution of *acervorum*.

The habits of the American subspecies are unknown. They probably resemble those of the European form, which lives in small colonies under bark, in moss, etc.

3a. Var. yankee Emery.

L. canadensis Prov. var. *yankee*, Zool. Jahrb., VIII, '94, p. 319. ☿ ♀.

The worker (fig. 5) differs from the worker of *canadensis typ.* in lighter coloration and in having somewhat longer epinotal spines. Head dark-brown, gaster somewhat paler; mouth, thorax, pedicel and legs reddish; antennal club, thoracic dorsum and femora usually infuscated. Sculpture finer and less rugose than in *canadensis*. In the female the thorax is dark-brown, the sculpture more pronounced.

Type localities: South Dakota, Utah, Colorado.

Several workers sent me by Rev. P. J. Schmitt, O.S.B., from Boulder, Colo., agree very well with Emery's description.

3b. Var. convivialis var. nov.

Length of worker 2–2.5 mm.; of female 3 mm. Differs from the typical *canadensis* and the preceding variety, in its small size and very deep coloration. Head, thorax, abdomen, femora and tibiæ black, neck, ventral portions of pedicel, funiculus, trochanters, knees and tarsi red or yellow. Epinotal spines short and blunt. Sculpturing of body as rough as that of the typical *canadensis*. Color of the female deeper than that of the worker, the shining region of the mesonotum is more extensive than in the female of *canadensis*, and there is a large shining area devoid of sculpture in the middle of the scutellum.

Type locality: Milwaukee, Wis.

Additional localities: Colebrook, Conn.; top of Las Vegas Range (11,000 feet), N. M. (T. D. A. Cockerell); Beulah, N. M. (F. W. P. Cockerell).

This variety seems to have a pronounced tendency to symbiosis with other species of Myrmicidæ. The Milwaukee specimens were found living in the bark of a stump in xenobiosis with *Cremastogaster lineolata* Say. Those from the top of the Las Vegas Range were taken by Prof. Cockerell in a nest of *Myrmica brevinodis*. The Connecticut specimens appeared to be living in plesiobiosis with *Formica rufa* subsp. *difficilis* Emery.

3c. Var. Kincaidi Pergande.

L. Yankee Emery var. *Kincaidi* Pergande, Proceed. Wash. Acad. Sci., Vol. II, December 20, 1900, pp. 520, 521. ☿ ♀.

"*Female.*—Length about 4 mm.

"Head and thorax black, the abdomen dark-brown, with the posterior edge of the segments brownish-yellow; antennæ, mandibles and legs yellowish-red, the neck and paler parts of the nodes of a darker red; the flagellum grows gradually darker toward the end, with the last joint black; femora dark-brown, their base and apex yellowish-red; teeth of mandibles black. Head finely striated, the striæ most distinct in front of the eyes and between the frontal carinæ; the posterior half of the head is finely and rather densely rugose or reticulate, the clypeus is almost smooth and the mandibles striato-punctate; pronotum and mesonotum quite coarsely rugose, the metanotum, scutellum and upper surface of nodes finely, though rather indistinctly, striated; declivity of the metathorax transversely striated. Abdomen smooth. Erect hairs short, truncate and pale-yellowish, those of the nodes and abdomen longest; there are also a few much finer, erect hairs on the femora.

"The female resembles somewhat that of *L. yankee*, which, however, is somewhat smaller, the last antennal joint and metanotal spines shorter, the hairs of the abdomen much finer and the erect hairs of the femora wanting.

"*Worker.*—Length about 3 mm.

"Head and teeth of mandibles black, the abdomen dark-brown; antennæ, mandibles, thorax, legs and nodes reddish-yellow; coloration of the last three or four joints of the antennæ and the femora as in the female, the upper surface of the thorax and nodes more or less decidedly reddish-brown. Striation of the head more distinct than in the female, and the space between the striæ more or less distinctly reticulated, particularly so toward the sides. Pronotum and mesonotum and the nodes finely rugose; sculpturing of the metanotum slightly coarser. Abdomen smooth; all the hairs similar to those of the female.

"The worker is very similar in appearance to those of *L. yankee*, though somewhat larger, more robust, the sculpturing coarser and the hairs stouter."

Type locality: Metlakahtla, Alaska (June). Cat. No. 5,278 U. S. National Museum.

Described from one female and twelve workers.

4. Leptothorax Provancheri Emery.

Myrmica tuberum Provancher, Natur. Canad., V, 12, 1881, p. 3592. Faune Entom. Canad., Hyménopt., 1883, p. 602. ☿.
Leptothorax Provancheri Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, pp. 317 and 320. ☿.

Worker.—Length 2.75 mm.

Body robust. Antennæ 11-jointed. Thorax stout, impressed at the mesoëpinotal suture. Epinotal spines short, tooth-like, resembling those of *L. canadensis* var. *yankee*. Petiole with subparallel sides, node angulate above. Postpetiole about half again as broad as the petiole, transversely elliptical.

Opaque, rugose-punctate; sculpturing like that of *acervorum*, the rugæ on the head less numerous, forming wide meshes. Postpetiole very smooth and shining, with a few piligerous punctures, but otherwise impunctate. Gaster smooth and shining, with short longitudinal striæ at its extreme base.

Hairs rather long, clavate, both on the body and on the tibiæ.

Testaceous, crown of head infuscated.

Type locality: "Canada" (Provancher).

Redescribed by Emery from a single specimen, Provancher's original description being inadequate for the identification of the species.

5. Leptothorax Emersoni Wheeler.

L. Emersoni Wheeler, Am. Natural., XXXV, 1901, pp. 433–436. ☿♂♀.

Worker (Pl. XII, fig. 6).—Length 2.5–3.3 mm.

Head rather convex above, excluding the mandibles not much longer than broad, sides rounded, posterior margin very faintly excised in the middle. Eyes rather large, convex, in the middle of the lateral surface of the head. Ocelli often present. Clypeus large, convex, broadly rounded in front. Mandibles 6-toothed. Antennæ 11-jointed, scape reaching nearly to the posterior angle of the head; first funicular joint but little longer than the second and third joints together; terminal joint not quite as long as joints 7–9 of the funiculus. Thorax rather long, rounded in front, narrowed behind, with distinct promesonotal and mesoëpinotal sutures, the thorax distinctly constricted at the latter. Epinotal spines short, blunt, compressed, hardly longer than broad at their bases, directed somewhat upward and backward, their distance apart at the base greater than their length. Petiole from above oblong, 1½ times as long as broad, sides slightly convex just in front of the middle; in profile the node is pointed, with distinctly concave anterior and posterior slopes. In some specimens, however, the posterior slope is straight or even somewhat convex. Ventral portion compressed, produced forward as a blunt projection. Postpetiole campanulate, with evenly convex dorsal surface; seen from above it is nearly twice as broad as the petiole, its anterior portion evenly rounded, not angulate. Gaster rather large, of the usual shape, without distinct anterior angles.

Head opaque. Mandibles coarsely punctate. Clypeus smooth in the middle, with a few longitudinal rugæ on either side. Head traversed by coarse longitudinal and occasionally anastomosing rugæ; interrugal spaces coarsely and more or less confluently foveolate-punctate. Around the eyes the rugæ become more reticulate, though they still have a distinctly longitudinal trend on the cheeks and lower surface of the head. Thorax opaque, its dorsal surface resembling the head in sculpture, except that the rugæ are more reticulate and without longitudinal trend. On the pleuræ the rugæ become indistinct and are replaced by even and closely aggregated foveolæ. Petiole opaque, sculptured like the pleuræ. Postpetiole smooth and shining above, delicately reticulate under a high magnification, especially on the sides. Gaster very glabrous and shining.

Whole body, including the legs and antennæ, abundantly beset with rather long, suberect, whitish hairs, which on the trunk are obtuse but by no means clavate. Hairs on the gaster longest and most regularly arranged.

Yellow or reddish-yellow, dorsal surface of head, terminal half of funiculus and the gaster, with the exception of the anterior, lateral and posterior borders of the segments, both on the dorsal and ventral surfaces, black or dark-brown.

Female.—Length 2.5–3.5 mm.

Like the worker. Thoracic dorsum dark-brown, rather shining; mesonotum and scutellum traversed by distinct, rather widely separated, longitudinal rugæ; pronotum and epinotum coarsely reticulate rugose, the rugæ of the latter being continued up onto the dorsal and lateral surfaces of the stout, blunt spines. Pleuræ subopaque, coarsely reticulate rugose, the meshes being occupied by aggregated shallow foveolæ. Node of petiole somewhat more acute than that of the worker. Wings grayish hyaline, veins and stigma dirty yellowish.

Male.—Length 2.5–3 mm.

Mandibles very small, not distinctly dentate and far from meeting each other with their blades. Antennæ 12-jointed; scape hardly as long as the three first joints of the funiculus together, first funicular joint very short, the others cylindrical, of uniform thickness but increasing gradually in length toward the tip. Parapsidal and other thoracic sutures very distinct. Epinotum with two very short rugose projections in the place of the spines. Petiolar node low, rounded, its anterior slope slightly concave, its posterior slope shorter and convex. Postpetiole hemispherical. Gaster somewhat less flattened and narrower than in the worker.

Mandibles striated. Clypeus even in the middle with a few delicate longitudinal rugæ. Head above longitudinally reticulate rugose; rugæ radiating backward and laterally from the posterior ocelli as centers. Thorax rather smooth, indistinctly punctate. Pedicel and gaster glabrous.

Hairs almost completely absent on the head and thorax, short and inconspicuous on the legs, long on the pedicel and gaster, but nowhere truncated at their tips.

Brownish-yellow like the worker. Head, thoracic dorsum, pedicel and gaster, and the middle portions of the femora and tibiæ somewhat darker. Wings as in the female.

Type locality: Colebrook, Litchfield county, Conn. Males and females appearing in August.

This species always lives in xenobiosis with a larger Myrmicine ant (*Myrmica brevinodis* Emery) in the hummocks of moss (*Polytrichum commune*), under stones, bits of wood, etc., in rather damp, grassy bogs. The *Leptothorax* occupy separate nests, which, however, com-

municate by means of narrow passages with the galleries and chambers of the *Myrmica*. They obtain their food by licking the surfaces of the *Myrmica* and by regurgitation. All sorts of transitional forms occur between the workers and queens (ergatoids and macroërgates with from one to three ocelli).

6. Leptothorax Schaumi Roger.

L. Schaumi Roger, Berl. Ent. Zeitschr., VII, 1863, p. 180, No. 70. ☿.
L. Schaumi Mayr, Verh. Zool. bot. Ges. Wien, XXXVI, 1886, p. 451. ♂.
L. Schaumii Dalla Torre, Catalog Hymenopt., VII, 1893, p. 127.
L. Schaumi Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, p. 320.

Worker (Pl. XII, fig. 7).—Length 2.5–2.75 mm,

Mandibles 5-toothed. Clypeus convex without median impression; its anterior border rather straight. Antennæ 11-jointed; scape reaching hardly to half way between the eye and the posterior angle of the head, funiculus with a distinctly 3-jointed club; first funicular joint almost as long as joints 2–5 together; joints 2–7 distinctly broader than long; terminal joint fully as long as the two preceding joints. Thorax rather short, flattened dorsally and laterally, broader in front than behind, with distinct and rather sharp humeral angles, and with a constriction at the mesoëpinotal suture. Epinotal spines very short, dentiform, not longer than broad at their bases. Petiole seen from above oblong, 1½ times as long as broad, its sides parallel except at the peduncle which is narrower; in profile the anterior dorsal slope is concave and about the same length as the straight or somewhat convex posterior slope; ventral surface with a distinct tooth directed forward. Postpetiole scarcely half again as broad as the petiole, distinctly broader than long, oblong, with distinct though rounded anterior angles. Its dorsal surface is evenly semicircular in profile. Gaster of the usual shape, with small but distinct anterior angles.

Clypeus with sharp longitudinal rugæ, two of which, near the middle, are more prominent than the others. Mandibles with distinct longitudinal rugæ. Head, clypeus and mandibles with a silky luster, the first traversed by fine parallel rugæ separated by rows of foveolate punctures, which are clearest in certain lights on the posterior lateral surfaces and cheeks. Thorax, petiole and postpetiole opaque, covered uniformly with foveolate punctures. Gaster smooth and shining.

Hairs moderately numerous on the body, white, erect, clavate; short on the head and thorax, much longer on the gaster and of intermediate length on the pedicel. Hairs on the antennæ and legs minute, non-clavate, appressed.

Yellowish-red, the edges of the mandibles black. Gaster in some specimens dark-brown throughout, in others yellow or with much of

the base of the first segment yellow. Antennæ and legs yellow, club and sometimes also the scape of the former, infuscated.

Male.—Length 3.2 mm.

Mandibles dentate, touching each other with their blades. Antennæ 12-jointed, scape about as long as the first three joints of the funiculus together; funiculus from the second joint to the end of uniform thickness, filiform; second joint a little shorter than the third, shorter, in fact, than any of the succeeding joints. Instead of spines or teeth, the epinotum bears two indistinct elongate swellings. Radial cell of wings short and closed.

Mandibles rather smooth and shining, with scattered punctures near their inner edges. Clypeus moderately shining and very delicately longitudinally rugose. Cheeks and region between antennal insertions and eyes sharply striated longitudinally; front with delicate longitudinal rugæ; vertex finely reticulate punctate. Thorax rather smooth and shining, median and posterior portions of mesonotum finely longitudinally rugose and in part obliquely. Petiole, postpetiole and gaster smooth and shining.

Pilosity sparse, tibiæ without suberect hairs.

Blackish-brown, pedicel and gaster darker. Mandibles, antennæ except the brown scape, joints of legs, tarsi, and in part also the joints of the pedicel, yellow or reddish-yellow. Wings clear, hyaline.

Type locality: "Pennsylvania" (Schaum).

Additional localities: District of Columbia (Pergande); Beatty, Pa. (Schmitt); Westville, N. J. (Schmitt); Austin, Tex.

In the locality last mentioned I have occasionally taken the workers of *L. Schaumi* running on the bark of large willows (*Salix nigra*).

7. Leptothorax fortinodis Mayr.

L. fortinodis Mayr, Ver. Zool. bot. Ges. Wien, XXXVI, 1886, pp. 451, 452. ♀ ☿.

L. fortinodis Dalla Torre, Catalog. Hymenopt., VII, 1893, p. 124.

L. fortinodis Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, pp. 318, 321.

Worker (Pl. XII, fig. 8).—Length 2.5–3 mm.

Head somewhat longer than broad, sides subparallel, occipital border nearly straight. Eyes moderately large and convex. Mandibles 5-toothed. Clypeus convex, its anterior border broad and rounded. Antennæ 11-jointed; scape reaching to midway between the eye and the posterior angle of the head; funiculus terminating in a 3-jointed club; first funicular joint as long as joints 2–4 together; joints 2–5 broader than long, 6 and 7 as long as broad; terminal joint somewhat

longer than the two preceding joints of the club. Thorax moderately long, its dorsal and pleural surfaces flattened; humeral angles prominent and rather sharp; no constriction between the meso- and epinotum. Epinotal spines very short, not longer than broad at their bases turned upward. Pedicel rather robust; petiole oblong when seen from above, almost twice as long as broad; sides of the nodal portion nearly parallel, peduncle narrower; in profile the anterior slope is distinctly concave, the posterior strongly convex, the apex of the node rounded anterior ventral surface with a prominent tooth, directed forward and downward. Postpetiole but little broader than the petiole; nearly as long as broad, subglobose, strongly arched dorsally, its anterior about as broad as its posterior border, the anterior angles rounded hardly distinct. Gaster of the usual configuration, with small but prominent basal angles. Legs robust.

Mandibles and clypeus longitudinally rugose, the former finely and indistinctly, the latter more coarsely and distinctly. Head opaque except the crown and occiput which are more or less shining or lustrous, covered with foveolate punctures, in addition to which the front and crown are finely longitudinally rugose, the cheeks and sides reticulate-rugose, the lower surface more indistinctly reticulate Thorax, petiole and postpetiole opaque, or slightly lustrous, densely and evenly foveolate-punctate. Gaster smooth and shining.

Hairs on the body yellowish-white; erect and clavate on the head thorax and abdomen; longest on the gaster; on the antennæ and legs the hairs are minute, tapering and appressed.

Head, thorax and pedicel deep reddish-brown, gaster almost or quite black; mandibles, antennæ and legs red, club of antennæ and often also the femora infuscated.

Female (deälated).—Length 3.5–4 mm.

Like the worker in coloration, except that the anterior and lateral portion of the mesonotum, the epinotum and dorsal surfaces of the petiolar and postpetiolar nodes may be distinctly infuscated. Whole upper surface of head longitudinally rugose, the rugæ diverging to the corners of the head in the postocellar region. Mesonotum and scutellum traversed by numerous parallel longitudinal rugæ, which are finer than those on the head; pronotum finely reticulate, median portion of scutellum smooth and shining; pleuræ reticulate-punctate, rather rough, the rugæ somewhat longitudinal in direction. Epinotal spines very small and tooth-like, rather blunt; the region between and below them densely foveolate-punctate. Petiole with less convex

anterior slope to the node; postpetiole relatively shorter and broader than in the worker.

Type locality: Maryland.

Additional locality: Austin, Tex.

The specimens from Austin have the head, thorax and pedicel decidedly paler in color than a type specimen received from Dr. Mayr and three topotypes given me by Mr. Pergande; the petiole is relatively smaller and there is a clavate hair at the base of each epinotal spine as in *Schaumi*. This hair is lacking in my types of *fortinodis*, possibly because these are much rubbed.

I have found only a single colony of this form at Austin. This had taken up its abode in an abandoned gall of *Holcaspis cinerosus* Basset on the live-oak (*Quercus virginiana*). It contained 143 workers, a single deälated queen and 35 larvæ in different stages. The latter were white and not greenish like the larvæ of *L. obturator* which inhabits the same kind of galls. The entrance to the *fortinodis* nest was a small round hole with much worn edges, evidently the modified exit of some parasite on the *Holcaspis*.

7a. Var. **melanoticus** var. nov.

Worker.—Length 2–2.5 mm.

This form is decidedly smaller and much deeper in color than the typical *fortinodis*. Whole body black, petiole and postpetiole brownish behind and below; mandibles, joints of legs, tarsi and funiculus brown. Epinotal spines very short and blunt in some specimens, in others acute and longer, recalling the conditions described by Mayr for a small variety of *fortinodis* from the District of Columbia.

Female (deälated).—Length 2.9–3 mm.

Decidedly smaller than the typical form, head and thorax as well as the pedicel and gaster black; the ventral surface of the petiole and postpetiole reddish. Legs dark-brown or black; coxæ, knees, tarsi and basal portion of funiculus somewhat paler.

Type locality: Rockford, Ill.

The workers of this apparently somewhat depauperate form are sometimes seen running on the bark of large prostrate oak logs in the woods. They inhabit small flat chambers only ½ to ¾ inch in diameter excavated in the thick corky bark. Each nest contains a single deälated queen and a comparatively small number of workers (about 25 to 40).

7b. Var. **gilvus** var. nov.

Worker.—Length 2.25 mm.

Differs from the typical *fortinodis* in the color, which is throughout

a clear yellow, and in the sculpturing of the head, which is smooth and shining except on the sides, where it is more opaque and reticulate. The vertex is traversed by a few rather widely separated rugæ.

Female (deälated).—Length 4 mm.

Differs like the worker in coloration. The whole body is yellow, except the wing insertions, which are black.

Type locality: Austin, Tex.

This variety is based on a single deälated queen which was found accompanied by seven workers and a few larvæ in a small *Holcaspis cinerosus* gall on a live-oak tree. These evidently constituted an incipient colony, remarkable because the queen and two workers were pure yellow, while the five remaining workers were dark-brown with black gasters, like the workers of the typical *fortinodis*. All the workers, however, had the peculiar smoothness of the head and were undoubtedly the offspring of the same mother. I believe this colony must present a case of hybridism, a female of the new variety *gilva* having been fertilized by a male of the typical *fortinodis*. It is difficult to explain the peculiar dichromatism of the workers in this little colony in any other way, since the yellow workers were not callows but perfectly mature, and the queen differed so decidedly in color from the majority of her offspring. Unfortunately the colony was killed by dropping the gall into alcohol before the peculiarities of the worker were noticed.

The Austin specimens of *fortinodis*, together with those representin the varieties *melanoticus* and *gilvus*, all have the petiole much smalle than in Mayr's type and suggest transitions to *Schaumi*. Particularl is this the case with var. *gilvus*, which is based on the female. Th female of *Schaumi* and the males of both species being unknown, am unable to delimit the two species accurately.

8. Leptothorax longispinosus Roger.

L. longispinosus Roger, Berl. Ent. Zeitschr., VII, 1863, p. 180, No. 69.
L. longispinosus Mayr, Verh. Zool. bot. Ges. Wien, XXXVI, 1886, p. 451.
L. longispinosus Dalla Torre, Catalog. Hymenopt., VII, 1893, p. 125.
L. longispinosus Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, p. 321. ☿

Worker (Pl. XII, fig. 9).—Length 2.25–2.5 mm.

Head exclusive of the mandibles not much longer than br posterior angles considerably rounded. Mandibles 5-toothed. I of moderate size, rather flattened. Clypeus convex, not impre in the middle, its anterior border rounded. Antennæ 11-joi scape reaching the posterior angle of the head, club 3-jointed; funicular joint as long as joints 2–4 together; joints 1–3 broader long; joints 4–6 as long as broad; terminal joint as long as the tw

ceding joints together. Thorax rather short, anterior angles rounded but distinct, dorsal surface and pleuræ somewhat flattened; meso-ëpinotal suture distinct but without a constriction. Epinotal spines very long and stout, directed backward, rather suddenly tapering at their tips which are curved slightly inward and downward. Petiole from above suboblong, twice as long as broad, sides nearly parallel, posterior border a little broader than the anterior; in profile the anterior slope is distinctly and evenly concave, the posterior convex; the anterior ventral surface has a distinct but rather blunt tooth; summit of node blunt. Postpetiole hardly half again as broad as the petiole, as long as broad, with rounded but distinct anterior angles, convex dorsally. Gaster of the usual shape, with distinct anterior angles.

Mandibles coarsely longitudinally rugose, hardly shining. Clypeus somewhat shining, traversed even in the middle by several clean-cut longitudinal rugæ. Head shining, especially on the posterior and postero-lateral portions; anteriorly with clean-cut longitudinal rugæ, which are coarsely reticulate and further apart on the cheeks, more delicate on the crown and occiput. Thorax opaque, except the mesonotum, which is somewhat shining. Neck coarsely and evenly punctate; remaining surface of thorax covered with coarse, irregularly longitudinal rugæ which extend up on the epinotal spines; interrugal spaces with shallow foveolate punctures, forming a secondary reticulation. Petiole and postpetiole opaque, coarsely rugose and punctate. Gaster very smooth and shining.

Hairs silvery-white, those on the head, thorax and abdomen very regularly arranged, clavate, erect; on the antennæ and legs minute, non-clavate and appressed.

Head and gaster black; thorax and pedicel dark-brown; antennæ and legs yellow; scape and club of the former, coxæ, femora and sometimes also the tibiæ of the latter, infuscated. Mandibles dark-brown, their distal half yellow.

Female.—Length 3.5–4 mm.

Head opaque, densely and rather finely longitudinally rugose. Eyes moderate; ocelli rather small. Thorax opaque; pronotum coarsely longitudinally rugose; mesonotum traversed by numerous very regular, parallel rugæ. Scutellum somewhat shining, covered with much more delicate rugæ than those of the mesonotum and more reticulate and less longitudinal in direction. Pleuræ, epinotum and epinotal spines covered with coarse reticulate rugæ, which have a decidedly longitudinal trend. Epinotal spines shorter, stouter and less curved than those

of the worker. Petiole and postpetiole opaque and more roughly sculptured than those of the worker. Wings milky-white, the veins and stigma very pale. Pilosity and color of body, legs and antennæ like the worker, except that the thorax is darker and often quite black, especially on the dorsal surface.

Male.—Length 2–2.5 mm.

Head, exclusive of the mandibles, about as broad as long. Eyes very prominent; ocelli reniform. Mandibles overlapping, small, acute, dentate. Antennæ 12-jointed; scape as long as joints 1–4 of the funiculus, the funiculus with a 4-jointed club; first funicular joint swollen, somewhat longer than joints 2–3 together; joints 3–7 cylindrical, about twice as long as broad, joints of club fusiform gradually increasing in length distally. Thorax with strongly marked parapsidal and Mayrian furrows. Epinotum evenly rounded, with two small prominences in the place of the large spines of the worker and queen. Petiole larger and postpetiole more slender than in the worker and both with much lower nodes, the former somewhat pedunculate, the latter subquadrate from above, with rounded angles, as long as broad and hardly half again as broad as the petiole. Gaster of the usual shape. Legs rather long and slender.

Clypeus shining, with a few clean-cut, longitudinal rugæ. Head subopaque, indistinctly rugose and punctate except the cheeks, where the rugæ are pronounced and reticulate. Thorax smooth; pleuræ, mesonotum and scutellum shining, their surfaces indistinctly and irregularly punctate at the sutures. Epinotum opaque, very finely rugose. Petiole and postpetiole opaque, finely rugose; the upper surfaces of the nodes, especially of the postpetiole, smooth and almost shining. Gaster subopaque.

Hairs on the body few and very slender, whitish; longest on the gaster; those on the legs and antennæ minute and appressed.

Black; mandibles, antennæ, legs and genitalia white. Bases of mandibles, scape, antennal club, coxæ, femora, tibiæ and last tarsal joint of each foot, distinctly infuscated. Wings milky-white with very pale veins and stigma.

Type locality: "America."

Additional localities: Virginia (Mayr); District of Columbia (Pergande); New York (Schmelter); Colebrook, Litchfield county, Conn.

This species is evidently allied to *L. curvispinosus*, but is readily distinguished by its dark coloration, strong epinotal spines, shining head, etc. The specimens from which the above description was drawn may be considerably darker than Rogers' types. In most of

my material the thorax of the worker is black, and the head rather smooth so as to resemble the forms described by Emery from New York and by Mayr from Virginia.

L. longispinosus appears to be confined to the Eastern United States. At any rate I have not yet been able to find it in the Middle West or among my material from the Western States. At Colebrook, Conn., the workers of this species are often seen running over the leaves or bushes in rather damp, shady places. The nests, containing the winged females and males in August, were found in clefts of granite boulders and in worm-eaten hickory nuts on the ground under the trees in the woods. Some of the colonies were quite populous for *Leptothorax* colonies, others very small.

9. Leptothorax curvispinosus Mayr.

L. curvispinosus Mayr, Sitz. B. k. Akad. Wiss. Wien, LIII, 1866, p. 508. ☿.
Stenamma gallarum Patton, Am. Natural., 1879, p. 126. ☿ ♀.
L. curvispinosus Mayr, Verhand. zool. bot. Ges. Wien, XXXVI, 1886, pp. 451 and 453. ♀.
L. curvispinosus Dalla Torre, Catalog. Hymenopt., VII, 1893, p. 124.
L. curvispinosus Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, pp. 317 and 320.

Worker (Pl. XII, fig. 10).—Length 2–2.5 mm.

Mandibles 5-toothed. Clypeus moderately convex, with broadly rounded anterior border, without median impression. Antennæ 11-jointed, scape reaching to midway between the eye and the posterior corner of the head; funiculus terminating in a distinct 3-jointed club; first funicular joint nearly as long as the three succeeding joints together; joints 2–7 about as long as wide; terminal joint little longer than the two preceding joints of the club taken together. Thorax but little broader in front above than below and behind; humeri slightly angular; dorsum convex, without promesonotal and mesoëpinotal sutures and without a constriction at the latter region. Epinotal spines long and slender, tapering rather rapidly at their tips; directed backward and slightly upward, their tips incurved and slightly converging. Petiole from above more than twice as long as broad, distinctly narrower at the anterior peduncular end than behind; node in profile rather blunt, with longer and slightly concave anterior slope and convex posterior slope; lower surface laterally compressed, with a small but distinct downwardly directed tooth near the anterior end. Postpetiole globose, about half again as broad as the petiole, almost circular when seen from above. Gaster short, elliptical, with small but distinct basal angles.

Mandibles shining, with indistinct longitudinal striæ. Clypeus longitudinally rugose, even in the middle. Head opaque, covered

with fine longitudinal rugæ separated by densely foveolate punctures. Thorax opaque, coarsely and irregularly longitudinally rugose, except just back of the neck where there are a few transverse rugæ. The rugæ on different parts of the thorax are so fine that their trend is hardly discernible except under a high magnification. Lower pleuræ foveolate-punctate. Petiole and postpetiole somewhat less roughly sculptured than the head and thorax; both densely foveolate-punctate; punctures on the petiole somewhat coarser than on the postpetiole, which therefore often appears smoother. Gaster and legs smooth and shining.

Hairs whitish, those on the head, thorax and pedicel shorter and more clavate than those on the gaster. Hairs on the legs and antennæ short, non-clavate and appressed.

Yellow; head, thorax and gaster tinged with brown; mandibles, legs, antennæ and venter pale, sometimes whitish; edges of mandibles and a large triangular spot on either side of the first gastric segment, black or dark-brown. In some specimens the femora are slightly infuscated.

Female (deälated).—Length 2.75–3.3 mm.

Longitudinal rugæ of the head more prominent than in the worker. Pronotum coarsely reticulate-rugose. Mesonotum shining, especially in front and in the parapsidal regions, longitudinally rugose, as are also the paraptera and scutellum. Epinotum with coarse, transverse rugæ, especially below the spines, which are shorter and stouter than in the worker. Pleuræ and sterna coarsely longitudinally rugose. Sculpturing of the petiole and postpetiole like that of the worker but more pronounced, so that these segments are quite opaque. Upper surface of head, scutellum, posterior portion of epinotum, wing-insertions, lower pleuræ, posterior portions of petiole and postpetiole, a broad band across the first gastric segment and all except the borders of the posterior gastric segments, dark-brown or black.

Type locality: ? District of Columbia.

Additional localities: Virginia (Mayr); Beatty, Pa. (Schmitt); Belmont, N. C. (Schmitt); Covington, Ky. (Schmitt); New York (Emery); New Jersey (Emery).

This species in its typical form appears to be confined to the Eastern United States. Patton found small colonies of it nesting in the hollow galls on the golden-rod (*Solidago*). Rev. P. J. Schmitt, O.S.B., who has frequently taken the species in Pennsylvania, sends me the following note on its habits: "In one locality at least where *curvispinosus* was abundant the colonies were in saplings of ash, the tops of

which had been eaten off by cattle and hollowed out, perhaps by some larger insect than *Leptothorax*. At all events, when I visited these colonies in autumn (I knew of their existence by watching foraging workers going in and out of the nests) every colony had been dislodged and dispossessed of its premises by a species of wasp which was busily bringing in paralyzed spiders. The *L. curvispinosus* had then retired to hollows in stumps or logs or dead branches lying on the ground." This species is also of interest because it is enslaved by *Tomognathus americanus* Emery, in the nests of which it has been found by Pergande.

9a. Subsp. ambiguus Emery (Pl. XII, fig. 11).

L. curvispinosus Mayr subsp. *ambiguus* Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, p. 320.

Differs from the typical *curvispinosus* in the somewhat coarser sculpturing and the decidedly shorter and nearly straight epinotal spines.

Type localities: Hill City, S. Dak. (Pergande); Cleveland, O. (Wasmann); New York (Schmelter).

A number of specimens collected at Colebrook, Conn., have the same sculpturing as the typical *curvispinosus* but decidedly shorter epinotal spines. These were found running on the surfaces of leaves in the shade of very damp woods. I failed to discover the nests.

9b. Subsp. rugatulus Emery (Pl. XII, fig. 12).

L. rugatulus Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, p. 321.

Owing to the existence of the next subspecies (*annectens*), I feel justified in regarding Emery's *L. rugatulus* merely as a subspecies of *curvispinosus*. The type specimens were from South Dakota (Pergande) and Colorado (Pergande). Specimens from Seattle, Wash. (Kincaid), in my collection agree very closely with Emery's description. They differ from the typical *curvispinosus* in the following characters: The rugæ of the head and thorax are decidedly coarser, and longitudinal on the latter. Epinotal spines much shorter and hardly curved. Tooth on the anterior ventral surface of the petiole distinctly larger, blunter and directed downward and forward. Postpetiole broader than long, oblong when seen from above, with rather distinct anterior angles. In profile the upper surface of the postpetiole is almost angular, its ventral surface very short. Upper surface of head and gaster, with the exception of the posterior edges of the segments of the latter, dark-brown. Femora more or less infuscated in some specimens.

9c. Var. Cockerelli var. nov.

Worker.—Length 2–2.5 mm.

Differs from the typical *rugatulus* in having the head, thorax and

petiole less opaque, owing to the rugæ being further apart and th smooth interrugal spaces more prominent. Epinotal spines short and more acute. Postpetiole somewhat longer, being intermediate i shape between that of the typical *curvispinosus* and *rugatulus*, bu distinctly wider in front than behind, and with rounded but percep tible anterior angles. The coloration is also intermediate between th forms just mentioned. Upper surface of head pale-brown and mo of the cheeks, sides and front of head yellow than in *rugatulus*, where the infuscation of the gaster is limited to the posterior dorsal half c two-thirds of the first segment, leaving the remaining segments yellov

Female (deälated).—Length 3–3.5 mm.

Whole body, with the exception of the legs and antennæ, yellowish brown; head and gaster, with the exception of the base of its firs segment, darker. Antennæ and legs more yellowish. Pedicel, espe cially the petiole, very rough, and surmounted by a more acute nod than in the worker.

A fine living colony of this species, comprising more than a hundre workers and eight females, was sent me by Prof. T. D. A. Cockerel from Las Vegas Hot Springs, N. M. Fragments of bark accompany ing the ants showed that the nest was found in a tree trunk.

9d. Subsp. annectens subsp. nov. (Pl. XII, fig. 13).

Worker.—Length 2–2.5 mm.

This form has the epinotal spines long and thin, and shaped like tho of the typical *curvispinosus*. Head very coarsely longitudinally rugos subopaque. Pronotum evenly and coarsely foveolate-punctate, mes and epinotum opaque, coarsely reticulate rugose, the rugæ withou longitudinal trend. Petiole and postpetiole opaque, shaped like th of *rugatulus*, the former with a prominent ventral tooth, directed do ward and forward. Upper surface of head and whole dorsal surfac gaster, except a large, transversely elliptical spot on the ante portion of the first segment and the extreme posterior edge of this the remaining segments, dark-brown or black. Remainder of b brownish-yellow.

Type locality: Boulder, Colo.

Described from four specimens collected by Rev. P. J. Schn O.S.B.

This form is clearly intermediate in structure and coloration tween the typical *curvispinosus* and the subspecies *rugatulus*.

10. Leptothorax Schmittii sp. nov.

Worker (Pl. XII, fig. 14).—Length 2–2.25 mm.

Head conspicuously narrow, with parallel sides, decidedly long

than broad, with straight posterior border. Mandibles 5-toothed. Clypeus moderately convex, its anterior border with a small but distinct excision in the center and a distinct median carina extending nearly its full length. Antennæ 12-jointed; scape reaching the posterior corner of the head; first funicular joint as long as joints 2–4 together; second joint as long as broad; joints 3–8 nearly as long as broad; club distinctly 3-jointed, first and second joints subequal, together a little shorter than the terminal joint. Thorax rather long and narrow, widest in front where the humeral angles are sharp and prominent. In profile the pronotum rises very abruptly from the neck, so that a transverse ridge is formed which gives the thorax a square-shouldere appearance; dorsum flatly and evenly rounded, without mesoëpinotal constriction. Epinotal spines well-developed, longer than broad at their bases, tapering and pointed, directed distinctly backward though slightly upward and outward; in profile the ventral outline of the spines is distinctly concave, the dorsal convex. They are about as long as their distance apart at the base. Petiole about 1½ times as long as broad, distinctly broader behind than in front when seen from above; in profile the height of the node is fully equal to the length of the whole joint; its anterior surface is steep and somewhat concave, the top of the node abruptly truncated, the posterior slope so steep that it is even inclined forward below and forms somewhat less than a right angle with the extreme posterior dorsal surface of the petiole; ventral tooth well developed, directed downward. Postpetiole hardly twice as broad as the petiole, distinctly broader than long; its anterior wider than its posterior border, its anterior angles rather prominent. Gaster of the usual shape.

Mandibles not distinctly striated; shining, with a few coarse punctures. Clypeus shining, longitudinally rugose on the sides. Head very smooth and shining, covered with rather coarse but sparse piligerous punctures; sides of frontal area, cheeks and subocular region subopaque and delicately longitudinally rugose. Pro- and mesonotum very smooth and shining, with a few piligerous punctures passing over onto the pleuræ into delicate longitudinal rugæ, which become much coarser and distinctly reticulate on the sides and whole upper surface of the epinotum. Petiole and postpetiole opaque, reticulate and punctate-rugose. Gaster very smooth, shining.

Hairs white, only moderately abundant; clavate and erect on the thorax and crown of head, somewhat longer and more reclinate on the pedicel and gaster; the hairs on the sides of the head, antennæ and legs non-clavate, appressed; those on the clypeus thin and projecting.

Very dark-brown, almost black. Mandibles, neck, funiculus and legs yellow; scape and club of antennæ and the middle of the femora and tibiæ infuscated; edges of mandibles black.

Type locality: Cañon City, Colo.

Described from four specimens collected by Rev. P. J. Schmitt, O.S.B., to whom I take pleasure in dedicating this very striking species. It is quite unlike any of the other described North American forms in the shape of the thorax and petiole and the smoothness of the head, pro- and mesonotum.

11. Leptothorax nitens Emery.

L. nitens Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, pp. 318, 322, 323.

Worker (Pl. XII, fig. 15).—Length 2–2.25 mm.

Mandibles 5-toothed; basal teeth very small. Clypeus moderately convex, impressed in the middle and with sinuately excised anterior border. Antennæ 12-jointed; scape reaching to ⅔ the distance between the eye and the posterior angle of the head; funiculus terminating in a distinctly 3-jointed club, the two basal joints of which are subequal in length, together decidedly shorter than the terminal joint; first funicular joint as long as the three succeeding joints together, joints 2–7 of the funiculus slightly broader than long, the 8th about as long as broad. Thorax slender, somewhat broader in front than behind; compressed laterally, pronotum rather prominent and square in front, humeri rounded; in profile the dorsal surface is somewhat flattened and without mesoëpinotal constriction. Epinotal spines very small, tooth-like, hardly as long as broad at their bases, directed upward, about as far apart as they are broad at their bases. Petiole about 1½ times as long as broad, gradually widened behind when seen from above; in profile the node is very high, its anterior slope steep and concave, its summit very short and rounded, the posterior slope abrupt, the ventral tooth is distinct and pointed forward and downward. Petiole nodiform, a little broader than long, half again as broad as the petiole, its anterior angles much rounded. Gaster of the usual shape.

Mandibles smooth and shining, indistinctly striated and punctate. Clypeus smooth and shining, with a few longitudinal rugæ on its antero-lateral surfaces. Head very smooth and shining, minutely and sparsely punctate; sides of front, antennal foveæ and cheeks longitudinal rugulose. Thorax, petiole and postpetiole opaque, finely and regularly foveolate-reticulate. In some specimens more or less of the pro- and mesonotum is shining. Pleuræ faintly striated longitudinally. Gaster very smooth and shining.

Hairs moderately abundant, yellow; clavate on crown of head, thorax

and abdomen; erect and shorter on head and thorax; longer and slightly reclinate on the pedicel and gaster; hairs on sides of head, legs and antennæ minute, non-clavate, appressed.

Yellow, in some specimens crown of head, antennal club and dorsum of gaster slightly infuscated.

Type locality: American Fork Cañon, Utah (Pergande).

Additional localities: Pacific Grove, Cal. (Dr. H. Heath); Cañon City, Colo. (Rev. P. J. Schmitt, O.S.B.).

Emery described the species from a single specimen in which the thorax was shining. Examination of a number of California and Colorado specimens from the same nests shows this to be a common but by no means constant character; in a great many individuals the thorax is uniformly opaque throughout.

One of the colonies sent me by Dr. Heath was found in the ground, hibernating in a Termite burrow.

11a. Var. Heathii var. nov.

Worker.—Differs from the preceding in the coloration, which is constant in a whole colony sent me by Dr. Harold Heath from Pacific Grove, Cal. The body is brown, often rather dark, the legs and antennæ brownish-white without the distinct yellow cast of the typical form.

Found nesting in the ground under a stone.

11b. Subsp. occidentalis subsp. nov.

Worker.—This form combines the color characters of the type and the preceding variety. The ground color is yellow, the upper surface of the head, thorax and pedicel brown; the first gastric segment with a broad, brown dorsal band across its posterior half or two-thirds. Thorax and pedicel decidedly opaque. Antennal scape nearly reaching the posterior angle of the head, epinotal spines decidedly more robust than in the typical *nitens* and the var. *Heathii.*

Type locality: Friday Harbor, Wash.

Described from six specimens received from Prof. Trevor Kincaid.

12. Leptothorax texanus sp. nov.

Worker (Pl. XII, fig. 16).—Length 2.25–2.75 mm.

Head longer than broad. Eyes rather large. Mandibles 5-toothed. Clypeus moderately convex, its anterior border somewhat rounded. Antennæ 12-jointed; scape reaching nearly to the posterior angle of the head; funiculus terminating in a very distinct 3-jointed club, the last joint of which is somewhat longer than the two preceding joints; first funicular joint nearly as long as joints 2–5;

second funicular joint about as long as broad, the remaining joints broader than long. Thorax rather short, its humeral angles rounded, dorsum evenly and slightly rounded, without mesoëpinotal constriction. Epinotal spines moderate, distinctly shorter than the declivous surface of the epinotum, scarcely as long as their distance apart at the base, rapidly tapering, acute, directed upward, outward and backward. their tips slightly deflected. Petiole from above fully 1½ times as long as broad; its sides somewhat convex, so that its outline is subelliptical; in profile the anterior slope is abrupt and distinctly concave, the summit of the node flattened, and the posterior slope suddenly declivous; ventral tooth small, acute, directed downward. Postpetiole very large, fully twice as broad as the petiole; broader than long, its anterior and posterior angles rounded, so that it appears transversely elliptical from above; in profile it is very convex, especially in front. Gaster elliptical, depressed, without distinct anterior angles.

Mandibles coarsely striated. Clypeus traversed by several clean-cut longitudinal rugæ, subsiding on the posterior portion which is smooth and shining. Head subopaque, coarsely reticulate-rugose; the rugæ distinctly longitudinal only on the front and vertex; interrugal spaces secondarily reticulate. Neck evenly reticulate; thoracic dorsum very coarsely and irregularly reticulate-rugose; the spaces between the rugæ smooth and shining, because the secondary reticulation is indistinct or lacking. Pleuræ somewhat more delicately and evenly rugose. Petiole and postpetiole coarsely reticulate-rugose, interrugal spaces filled with shallow foveolæ or secondary reticulation. Gaster smooth and shining.

Hairs white, rather numerous and prominent; on the trunk clavate; shorter and more erect on the head and thorax, longer and slightly reclinate on the pedicel and gaster; on the legs and antennæ distinct, non-clavate, more or less appressed.

Black or very dark-brown, especially on the head, thorax and petiole. Mandibles, excepting the teeth, funiculus, tips of epinotal spines, tarsi and articulations of legs, excepting the last tarsal joint, yellow; antennal scape brown.

Female.—Length 3.75–4 mm.

Head more decidedly and extensively longitudinally rugose than in the worker. Neck delicately, pronotum more coarsely reticulate-rugose; mesonotum and paraptera traversed by numerous longitudinal rugæ which are more or less interrupted and have a tendency to anastomose. Scutellum with such rugæ only in front and on the sides,

posteriorly it is nearly smooth and shining. Pleuræ and epinotum with rather coarse, distinctly longitudinal rugæ. Epinotal spines small, acute, straight. Petiole with pointed node and more abruptly declivous posterior slope than in the worker, its dorsal surface scarcely flattened. Postpetiole very convex in front above. Sculpturing of petiole and postpetiole as in the worker. Color of head, thorax and pedicel reddish-brown, darker on the dorsal surface. Gaster black. Pilosity of body and legs and color of the latter much as in the worker. Wings whitish-hyaline; veins and stigma yellow.

Male.—Length 2–2.5 mm.

Head exclusive of the mandibles broader than long, cheeks short, posterior angles convex and rounded. Mandibles overlapping each other. Antennæ 13-jointed; scape as long as the first four joints of the funiculus, club very distinct, 4-jointed, the first, second and third subequal, fully 1½ times as long as broad, apical joint as long as the second and third together; first funicular joint somewhat swollen, fully 1½ times as long as broad; joints 2–8 longer than broad. Epinotum with two very small, indistinct protuberances in the place of the spines. Petiole slender, in profile concave below; anterior dorsal slope nearly straight, gradual, posterior slope shorter, abruptly declivous, rather concave. Postpetiole campanulate, about as long as broad; 1½ times as broad as the petiole. Legs long and slender.

Mandibles striated. Clypeus coarsely and irregularly reticulate-rugose, shining. Head subopaque, evenly and rather delicately reticulate-rugose. Neck finely reticulate; mesonotum shining, with a faint reproduction of the irregular rugosity of the worker; remainder of thorax and the pedicel delicately reticulate-punctate. Gaster smooth and shining.

Hairs white, non-clavate, long and moderately abundant on the mandibles, pedicel and gaster; sparser elsewhere.

Black; mandibles and genitalia yellow; antennal funiculus grayish-brown; wings like those of female; legs like those of the worker in color.

Type locality: Milano, Millan County, Tex.

All three sexual phases of this species were taken May 23, 1902, in nests consisting of a few small galleries, 3–4 inches long, excavated in the sand in rather damp spots under post-oaks and cedars.

13. Leptothorax tricarinatus Emery.

L. tricarinatus Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, pp. 318, 321, 322. ☿.

Worker (Pl. XII, fig. 17).—Length 2.25 mm.

Clypeus produced in front in the middle, obtusely angulate, above

with three slender longitudinal carinæ. Antennæ 12-jointed, first funicular joint longer than the three succeeding joints together; remaining joints shorter than broad; two basal joints of club subequal. Thorax not impressed at the mesoëpinotal suture. Epinotal spines short, rather acute, obliquely erect. Petiole thickened behind, node subconical, obtuse. Postpetiole much larger than the petiole, subglobose.

Mandibles striated. Clypeus shining. Head, thorax and petiole subopaque, punctate and finely rugose, pronotum more shining in the middle.

Hairs on the body clavate, on the legs and antennal scape nonclavate and sparse.

Fuscous black; mandibles, articulations of legs and the tarsi reddish.

Type locality: Hill City, S. Dak. (Pergande).

Described from a single specimen in the collection of Prof. C. Emery.

14. Leptothorax neomexicanus sp. nov.

Worker (Pl. XII, fig. 18).—Length 2.25–2.5 mm.

Head longer than broad. Mandibles 5-toothed. Clypeus moderately convex, broadly rounded in front, not impressed. Antennæ slender, 12-jointed; scape extending to a distance equal to its own breadth beyond the posterior angle of the head; funiculus terminating in a 3-jointed club, the two basal joints of which are subequal and together shorter than the terminal joint; first funicular joint as long as the three succeeding joints together; joints 2–8 of the funiculus as long as broad. Thorax not much broader in front and above than behind and below; humeral angles rounded; dorsal surface flattened, without mesoëpinotal suture or constriction. Epinotal spines short, robust, blunt, not longer than broad at their bases and nearly twice as far apart at their bases as long. They are directed obliquely upward, outward and backward. Petiole hardly 1½ times as long as broad; distinctly wider behind than in front, sides somewhat convex; in profile the node is nearly as high as the length of the petiole, its anterior slope steep, slightly concave; the summit somewhat truncated, passing abruptly into the angular posterior declivity; ventral surface in front with a prominent tooth, directed downward and forward. Postpetiole nearly twice as broad as the petiole; nearly as long as broad, subglobular, its anterior dorsal surface in profile abruptly convex, the posterior dorsal surface more flattened. Gaster of the usual shape with slight basal angles.

Mandibles coarsely striated and punctate. Clypeus longitudinally rugose, especially on the sides, behind without rugæ, smooth and

ıining, somewhat foveolate-punctate. Head subopaque except along broad median strip, extending from the frontal area to the occiput, nd on the posterior angles. These regions are smooth and shining. 'heeks and sides of head rather delicately and longitudinally reticuate-rugose. On the front and vertex there are also a few rather large ndentations at widely separated intervals. Thorax nearly opaque, n front delicately and evenly reticulate-rugose; on the epinotum and ıleuræ the rugæ are coarser and have a distinctly longitudinal trend. 'etiole and postpetiole nearly opaque, finely reticulate-rugose. Gaster ery smooth and shining.

Hairs rather sparse, silvery-white; those on the body subclavate, horter and more erect on the head and thorax, longer and more eclinate on the pedicel and gaster. Hairs on the legs and antennæ hort, non-clavate, appressed.

Black. In some specimens the pedicel and thorax are dark-brown. cape and funiculus of antennæ brown. Mandibles yellow, with black eeth. Legs yellow, middle portion of the femora and tibiæ and erminal tarsal joint on each foot, black.

Type locality: Manzanares, N. M.

Described from five specimens taken by Miss Mary Cooper. The pecies is obviously closely related to *L. tricarinatus* Emery, and nay prove to be merely a subspecies of this form. To judge from Emery's description, the head of *tricarinatus* is more opaque, the nesonotum shining, the first funicular joint larger than the three suceeding joints, the remaining joints of the funiculus shorter than broad. Apparently, also, the postpetiole is considerably larger than in *neonexicanus.*

5. Leptothorax obturator sp. nov.

Worker (Pl. XII, fig. 19).—Length 2.25–2.75 mm.

Mandibles 5-toothed. Clypeus rather flat, its anterior margin roadly truncated in the middle. Antennæ 12-jointed; scape reaching osterior angle of head; first funicular joint as long as the three suceeding joints; joints 3–8 broader than long, joints 9–11 forming a lub, the ninth distinctly narrower and shorter than the tenth, the erminal joint longer and considerably thicker than the two preceding oints. Thorax slender, somewhat broader in front than behind; ounded at the humeri, in profile convex in front and slightly concave ehind on the dorsal surface, without mesoëpinotal constriction. Epinotal spines small, rather acute, not longer than broad at their bases, nor further apart than long, directed upward. In front and

on the side of each epinotal spine there is a distinct longitudinal swelling or ridge on the epinotum. Petiole very slender, three times as long as broad, sides of the node parallel, the peduncle somewhat narrower when seen from above; in profile the lower surface is evenly concave, the anterior tooth minute; the dorsal surface with a low regularly rounded, knoll-like node. Postpetiole small, about 1½ times as broad as the petiole, as broad as long, square when seen from above, with prominent anterior angles; in profile the lower surface is flattened, the upper convex, especially in front. Gaster with distinct anterior angles. Sting well developed.

Mandibles opaque, striated and with a few coarse punctures. Clypeus subopaque, its whole surface longitudinally rugose. Head subopaque in front and on the sides, shining behind, on the former regions densely and rather finely reticulate-rugose; the rugæ with a distinct longitudinal trend except on an opaque patch above each eye, where the rugæ are evenly reticulate. The shining portion of the head is traversed by clean-cut longitudinal rugæ much farther apart than on the front and crown and interspersed with a few coarse punctures; posterior angles of head delicately reticulate. Thorax subopaque; pronotal region more shining, foveolate-reticulate on the whole dorsal surface; pleuræ more coarsely reticulate-rugose, with pronounced longitudinal trend in a few of the rugæ, especially in the upper meso- and lower metapleuræ. Petiole and postpetiole subopaque, rather evenly foveolate-reticulate. Gaster smooth and shining.

Hairs moderately abundant, snow-white; clavate on the crown of the head, thorax, pedicel and gaster; a little longer on the pedicel and gaster and somewhat more reclinate. Hairs on the legs and antennæ sparse, non-clavate, appressed and inconspicuous.

Black or very dark-brown. Mandibles, joints 3–9 of the antennæ, neck, ventral surface of petiole and postpetiole reddish-yellow. Legs reddish-yellow, except the middle of the coxæ, femora, tibiæ and last tarsal joint, which are black.

Female.—Length 3.5–3.75 mm.

Clypeus and head more coarsely longitudinally rugose and more opaque than in the worker. Thorax subopaque; neck delicately reticulate-rugose; pronotum transversely and irregularly rugose; mesonotum, paraptera and scutellum traversed by dense, parallel, clean-cut, longitudinal rugæ. Epinotum delicately and somewhat concentrically reticulate-rugose; armed with two inconspicuous swellings in the place of the spines; pleuræ longitudinally rugose. Petiole and postpetiole like those of the worker, the node of the former relatively lower; post-

petiole hardly 1½ times as broad as the petiole. The white hairs on the body are non-clavate, though those on the pedicel and gaster are somewhat thickened. Head, thorax and pedicel yellowish-red or dark-red, their upper surfaces more or less infuscated. Gaster black. Antennal scape black with basal half yellow; first joint of funiculus and club black, remaining joints yellow. Legs colored like those of the worker. Wings milky-white, veins yellow; stigma brown, conspicuous.

Male.—Length 1.5–2 mm.

Head as long as broad, exclusive of the mandibles; cheeks very short. Mandibles meeting with their tips. Clypeus convex, truncated in front. Antennæ slender; 13-jointed; scape nearly as long as the first five joints of the flagellum; first flagellar joint thickened, nearly as long as the three following joints together; joints 2–8 of the flagellum cylindrical, as long as broad; the four terminal joints forming a club, of which the three basal joints are subequal in length but increase somewhat in thickness distally; terminal joint much larger, distinctly longer than the two preceding joints. Epinotum with two very inconspicuous thickenings in the place of the spines. Petiole and postpetiole similar in shape to the corresponding segments of the worker, node of former very low.

Clypeus shining, with a few reticulate rugæ forming rather large meshes. Head, thorax and pedicel opaque, finely and evenly reticulate-rugose. Mesonotum sparsely foveolate-punctate and traversed by a narrow, smooth, longitudinal stripe. Pleuræ shining in part. Gaster smooth and shining.

Hairs white, sparse, non-clavate, most abundant on the thoracic dorsum, pedicel and gaster.

Black; pleuræ and pedicel more piceous. Mandibles, legs and antennæ white; the mandibles with brown edges, the antennæ with scape, second joint and club blackened; legs with the coxæ, middle of the femora and tibiæ and the last tarsal joint blackened.

Type locality: Austin, Tex.

Described from many specimens collected at different times from the abandoned *Holcaspis cinerosus* galls on the live-oaks (*Q. virginiana*). The young fertilized queen, on entering the gall to establish her colony, gnaws minute fragments from the ligneous wall, mixes these with some secretion (saliva?) and completely plugs up the round opening through which the *Holcaspis* escaped and she herself has entered. Later when the first batch of tiny workers appear, they perforate the center of the plug with a small opening like a pin-prick, and just large enough for egress and ingress. This opening is too small for

the queen to pass, so that she remains imprisoned. With the growth of the colony the chamber formerly made and inhabited by the *Holcaspis* larva is enlarged by the workers. The queen with the larvæ prefers to inhabit the small central capsule in which the *Holcaspis* passed its pupal life. The larvæ are of a peculiar greenish tint. The males and virgin females make their appearance in the colony during the last week of May. At no time are the colonies of *L. obturator* very large. They rarely comprise more than 36 or 40 workers. Members of different colonies, even from galls on the same branch, are extremely hostile to one another. Along the creek-bottoms near Austin, *L. obturator* is also occasionally found nesting in the twigs of the wafer-ash (*Ptelea trifoliata*) which have been hollowed out by tiny carpenter-bees (*Ceratina nanula* Ckll. and *C. arizonensis* Ckll.). The relatively large entrance made by the bees at the end of the twig is plugged up by the ants with agglutinated vegetable particles and then perforated with a minute opening in the center.

16. Leptothorax nevadensis sp. nov.

Worker (Pl. XII, fig. 20).—Length 2.5–3 mm.

Mandibles 5-toothed. Clypeus depressed in the middle, its anterior margin sinuately excised. Antennæ 12-jointed, scape reaching to posterior corner of the head, first funicular joint as long as joints 2–4 together, joints 2–6 slightly broader than long, joints 7 and 8 as long as broad; two basal joints of club subequal, together shorter than the terminal joint. Thorax above in front of about the same width as below and behind; humeri much rounded, dorsum flattened in profile, without mesoëpinotal constriction. Epinotal spines robust, pointed, decidedly longer than broad at their bases, and nearer together at their bases than long, directed upward, outward and backward. Petiole 1½ times as long as broad, sides of node rounded, broader than the peduncle; seen from above the node is transverse, in profile it is narrow antero-posteriorly, its anterior slope gently ascending, concave, its posterior slope more abrupt, also concave, summit rounded; ventral surface of petiole with a prominent, compressed, downwardly directed tooth. Postpetiole in profile with a prominent, sometimes slightly angular node; the segment seen from above is transversely elliptical, about half again as broad as long, its anterior angles rounded. Gaster and legs of the usual conformation.

Mandibles striate and punctate. Clypeus subopaque, its surface, especially at the sides, traversed by rather coarse longitudinal rugæ. Head with a satiny luster, sparsely punctate and with delicate longitudinal rugæ, which become decidedly reticulate in the antennal

foveæ. Thorax subopaque, its dorsal surface irregularly reticulate-rugose and foveolate, pleuræ, petiole and postpetiole regularly foveolate-punctate; posterior epinotal declivity rather coarsely longitudinally rugose. Gaster smooth and shining.

Hairs yellow, not very abundant; clavate on thorax, pedicel and crown of head; short and erect on head and thorax, longer and somewhat reclinate on the pedicel and gaster. Hairs on antennæ, legs and sides of head less conspicuous and appressed, except on the antennæ, where they are suberect.

Rather dark reddish-brown, ventral portions of head, thorax and pedicel and the incisures of the gastric segments, yellowish. Legs and antennæ yellowish, middle of femora and the antennal club dark-brown. Immature specimens have the thorax and pedicel more extensively yellow.

Female (deälated).—Length 4.5 mm.

Mandibles densely striated and somewhat punctate. Clypeus with coarse longitudinal rugæ, one of which forms a distinct carina in the middle of the sclerite. Frontal area opaque. Head with coarse and very regular longitudinal rugæ, but little diverging behind and but slightly reticulate. On the upper surface of the head there are also a number of shallow but distinct foveolæ in the interrugal furrows. Pronotum and pleuræ coarsely longitudinally rugose; mesonotum shining, sparsely foveolate and rather indistinctly longitudinally rugose, especially in front. Scutellum and paraptera like the mesonotum, the former with indications of rugæ only at its anterior border. Whole epinotum subopaque, coarsely rugose, even over the entire surface of the robust, pointed spines, which are as long as they are broad at their bases. Declivous surface of epinotum regularly transversely rugose. Petiole and postpetiole opaque, reticulate and punctate-rugose, more coarsely on the sides than on the summits of the nodes; petiolar node in profile more acute than in the worker. Gaster very glabrous. Head, thorax and pedicel rich reddish-brown; gaster decidedly darker. Legs and antennæ yellow. In the latter all the joints of the funiculus are distinctly longer than broad, and the club, which is not infuscated, is indistinct. Wing-insertions black, Hairs on the body sparse, yellow, not clavate like those of the worker, but more or less tapering.

Male.—Length 2.5–3 mm.

Mandibles dentate, overlapping with their blades. Clypeus convex, truncated in the middle in front. Antennæ 13-jointed; scape slender, as long as joints 1–5 of the funiculus. First funicular joint fully twice

as long as broad, much stouter than the succeeding joints, except those of the 4-jointed club; joints 3–7 longer than broad; three basal joints of club subequal, each not more than half as long as the terminal joint. Cheeks short. Thorax with very deep Mayrian and other sutures. Epinotum without indications of spines. Petiole and post-petiole longer and with lower nodes than in the worker. Gaster of the usual shape.

Mandibles and clypeus somewhat shining, the latter with a few prominent and irregular longitudinal rugæ. Head decidedly opaque, uniformly and densely punctate. Thorax shining, mesonotum, scutellum and pleuræ with faint, parallel, longitudinal striæ. Pronotum and epinotum more reticulate-rugose. Petiole and postpetiole smooth and shining on the summits of the nodes, elsewhere subopaque, finely reticulate-rugose. Gaster smooth and shining.

Hairs covering the body sparse, whitish, non-clavate, longest and most conspicuous on the gaster, very small and appressed on the legs and antennæ.

Black, thorax and pedicel more piceous, especially on their lateral and ventral surfaces. The following parts are yellowish, or yellow suffused with piceous: mandibles, except their teeth, which are black, antennæ, legs and genitalia. Wings whitish-hyaline, veins and stigma colorless.

Type locality: King's Cañon, Ormsby county, Nev.

Described from eight workers, one female and eight males, found by Mr. C. F. Baker during August, 1902, nesting in the ground under a stone.

This species appears to be similar to *L. tricarinatus* Emery, but differs in the shape of the clypeus, which is impressed and sinuately excised and not produced, and in the shape of the epinotal spines, petiole, etc.

17. Leptothorax terrigena sp. nov.

Worker (Pl. XII, fig. 21).—Length 1.5–1.75 mm.

Head rather narrow, with parallel sides. Mandibles 5-toothed. Clypeus moderately convex, without median impression and with broadly rounded, non-sinuate anterior border. Antennæ 12-jointed, scape extending to $\frac{3}{4}$ the distance between the eye and the posterior corner of the head; first funicular joint as long as the three succeeding joints together; joints 2–8 of funiculus decidedly broader than long, subequal; three terminal joints forming a distinct club, of which the two basal joints are subequal in length but not in thickness, and together shorter than the terminal joint. Thorax slender, somewhat broader in front than behind, with rounded humeral angles and moderately

elevated anterior pronotal border. Pleuræ compressed; dorsum flattened and without mesoëpinotal constrictions. Epinotal spines small, conical, distinctly longer and further apart than broad at their bases. Petiole short, hardly 1½ times as long as broad, sides of node convex when seen from above and much broader than the peduncle; in profile the node is high and very thick with an evenly rounded summit, very steep and concave anterior, and very abrupt posterior declivity; ventral tooth rather large, blunt. Postpetiole twice as broad as the petiole, distinctly broader than long, transversely elliptical from above, with rounded anterior angles. Gaster of the usual shape.

Mandibles and clypeus subopaque, the former longitudinally striated and with a few coarse punctures, the latter longitudinally rugose. Head opaque throughout, evenly and densely punctate except along the sides of the frontal region, where there are a few delicate longitudinal rugæ. Thorax, petiole and postpetiole opaque, densely punctate. Gaster smooth and shining.

Hairs white, moderately numerous, clavate on crown of head, thorax and abdomen; erect on head and thorax, more reclinate on the pedicel and gaster; minute, inconspicuous and appressed on the antennæ and legs.

Whole body, even the anterior portion of the gaster, golden-yellow, except the antennal club which is blackened.

Female (deälated).—Length 2.5 mm.

Head opaque, densely punctate; cheeks and whole preocellar region irregularly longitudinally rugulose, the postocellar region and posterior angles more reticulate. Thorax opaque, densely punctate; mesonotum and scutellum with very faint, parallel, longitudinal rugæ. Epinotal spines very short and stout, regularly conical, not as far apart as they are broad at the base. Petiole and postpetiole like those of the worker, but the latter segment fully twice as broad as long. Both segments of the pedicel densely punctate, opaque, except the dorsal surfaces of the nodes which are somewhat smooth and shining. Body brownish-yellow, legs pale-yellow. Antennal club, wing-insertions, sides and posterior border of first gastric segment, a broad transverse band on the second gastric segment and the tip of the gaster, dark-brown. Pilosity like that of the worker.

Type locality: Austin and McNeil (Travis county), Tex.

This small species lives in and on the ground. At Austin I have occasionally seen a few workers running about on the dry gravelly hill-slopes exposed to the sun. At McNeil I took a few dozen workers and a deälated queen, which were inhabiting a small spherical chamber

in the "black waxy" soil under the center of a large flat stone. Two other nests taken at Austin exhibited a tendency toward plesiobiosis. One of these was found in the vegetable débris at the very entrance of the nest of a timid fungus-growing ant (*Trachymyrmex turrifex* Wheeler), the other under a stone at the very edge of a flourishing colony of *Pheidole instabilis* Emery.

L. terrigena is undoubtedly closely allied to *L. Andrei* Emery, which I have not seen. The worker differs, however, in its decidedly smaller size, shape of petiole and postpetiole, its larger and stouter epinotal spines, the absence of a clypeal sinuosity, a shining longitudinal band on the front and vertex, and the absence of infuscation on the abdomen, although the last character is clearly present in the female.

18. Leptothorax Andrei Emery.

L. Andrei Emery, Morph. Jahrb. Abth. f. Syst., VIII, 1894, pp. 318, 322.

Worker (Pl. XII, fig. 22).—Length 2.25 mm.

Clypeus feebly carinate in the middle, its anterior border subsinuate. Antennæ 12-jointed; first funicular joint a little shorter than the three succeeding joints; second joint of club a little longer than the preceding joint. Thoracic dorsum without a mesoëpinotal constriction. Epinotal spines in the form of short, stout teeth. Petiole with a rather long peduncle, its node above subrotund. Postpetiole about a third broader than the petiole, a little broader than long.

Mandibles striated. Head opaque, longitudinally rugulose-punctate; cheeks and clypeus striated, the latter and a median line along the front and vertex shining. Thorax and pedicel opaque; the former densely, the latter more faintly punctate. Gaster and legs shining.

Hairs on the body sparse, short and clavate.

Testaceous, abdomen darker behind, legs pale.

Type locality: California (André).

The species was described from a single specimen in the collection of Prof. Emery.

19. Leptothorax (Dichothorax) Pergandei Emery.

L. (*D.*) *Pergandei* Emery, Zool. Jahrb. Abth. f. Syst., VIII, 1894, pp. 318–323, 324. ☿.

Worker (Pl. XII, figs. 23 and 23*a*).—Length 2.5–3.25 mm.

Mandibles rather broad, 5-toothed. Clypeus moderately convex, broadly rounded in front, with a distinct median carina. Antennæ 12-jointed, scape extending beyond the posterior angle of the head a distance fully equal to twice its breadth; first funicular joint as long as the three succeeding joints together; joints 3–8 nearly as long as broad; club 3-jointed, the two basal joints subequal, together shorter

than the terminal joint. Thorax long, rather robust, not much wider in front than behind, without abrupt declivity at the juncture of the neck and pronotum, pro- and mesonotum convex; mesoëpinotal constriction very deep and broad. Epinotal spines small, not longer than broad at the base, directed upward. Petiole from above nearly three times as long as its greatest width which is in the middle; in profile the node is low and rounded above, the anterior slope very long, at first nearly horizontal, then gradually ascending, the posterior slope shorter, somewhat flattened; summit of node distinctly impressed or concave when seen from behind; ventral surface of peduncle with a long but not very prominent tooth. Postpetiole fully half again as broad as the petiole, a little broader than long, nearly square, its anterior angles prominent, its dorsal surface in profile very convex, especially in front. Gaster rather large, of the usual shape. Sting well developed. Legs robust.

Mandibles longitudinally striated. Clypeus smooth, especially behind, its sides longitudinally rugose. Head smooth and shining above and behind, sparsely punctate and irregularly and delicately reticulate. Antennal foveæ with curved, parallel rugæ; front and cheeks with straight rugæ. Neck opaque and delicately rugose; pro- and mesonotum shining, very finely and irregularly reticulate, pleuræ, epinotum and mesoëpinotal constriction subopaque, coarsely reticulate-rugose; in the constriction and on the meso- and metapleuræ the rugæ have a distinctly longitudinal trend. Declivous surface of epinotum smooth and shining. Petiole and postpetiole shining and finely reticulate above, more opaque and reticulate-rugose on the sides. Gaster smooth and shining, finely and irregularly reticulate.

Hairs white, long and very abundant, obtuse but not clavate, erect on the trunk, suberect on the legs and antennæ.

Black or rich dark-brown, mandibles, antennæ, except the club, frontal carinæ, thorax, pedicel and legs yellowish-red or testaceous. In some specimens the dorsal surface of the thorax and nodes is blackened, while in others the whole of the thorax, nodes and legs is black except the peduncle of the petiole and the tarsi and joints of the legs, which are yellow.

Female.—Length 3.5–4 mm.

Apart from the usual sexual characters, differs from the worker in having the lower surfaces of the head, thorax, pedicel and the legs more yellowish. The smooth surfaces of the body are hardly reticulate. Mesonotum adorned with a median brown blotch on its anterior half and a large comma-shaped spot on either parapsis. Scutellum, epi-

notum and pleuræ more or less spotted with brown, and a small black spot at the insertion of the forewing. Femora and tibiæ infuscated in the middle. Antennal club infuscated. Wings milky-hyaline, with colorless veins and stigma. Concavity at summit of petiolar node very distinct; postpetiole nearly twice as broad as long. Epinotal spines distinctly shorter than broad at their bases.

Male.—Length 2–2.25 mm.

Head a little longer than broad; cheeks very short, eyes and ocelli prominent. Mandibles overlapping, 4-toothed. Clypeus convex. Antennæ 13-jointed, scape about as long as the five succeeding joints, first funicular joint about as long as the second and third together; joints 3–8 slender, cylindrical, subequal, twice as long as broad; club 4-jointed, the three basal joints subequal, together as long as the terminal joint. Thorax long, mesonotum rounded, projecting forward, so that the head is scarcely visible when the insect is viewed from above. Epinotum with a pair of slight projections in the place of the spines. Petiole long and slender, like that of the worker but with lower node. Postpetiole as long as broad, square from above, in profile with the node highest in the middle of the segment and rounded. Gaster and legs of the usual conformation.

Mandibles and clypeus subopaque, the latter coarsely rugose. Head shining, very irregularly and sparsely reticulate, in front of the ocelli with a few shallow foveolæ. Pronotum subopaque, reticulate; mesonotum very smooth and shining, finely reticulate. Scutellum and epinotum more opaque, disk of former coarsely reticulate, sides of both longitudinally rugulose. Petiole and postpetiole opaque, more shining above, delicately corrugated. Gaster very smooth and shining.

Hairs white, rather sparse and long, even on the legs and antennal scape, where they are reclinate but not appressed.

Black. Mandibles, antennæ and legs white except the following portions, which are infuscated or blackened: Edges and teeth of mandibles, terminal joint of antennæ, basal two-thirds of coxæ, middle of femora and tibiæ and last tarsal joint. Wings like those of the female.

Type locality: Washington, D. C. (Pergande).

Additional localities: Morgantown, N. C. (Forel); Austin, Tex.; San Angelo, Tom Green County, Tex.; Toronto, Brewster County, Tex.

The type specimens of this fine species were taken by Mr. Pergande in a nest of *Monomorium minutum* Mayr var. *minimum*, and it was supposed that the *Leptothorax* was a guest in the nests of the *Monomorium*, but Forel, who observed the species in North Carolina, showed that this was altogether an exceptional case. He found *L. Pergandei*

living "in independent formicaries, in the moss of woods or in the earth of meadows, like the ordinary species of *Leptothorax*" (*Ann. Soc. Ent. de Belg.*, Tome XLV, 1901, pp. 389–398). In Texas I have had ample opportunity to observe the habits of this ant, especially in the neighborhood of Austin, where it is found making its nests in very sparsely grassy spots among the mesquite and Opuntia thickets. The nests can be found only by carefully tracking foraging workers, as the entrance is a small hole often concealed under a dead twig or a tuft of grass roots. The colonies are hardly more populous than those of other species of *Leptothorax*. The winged forms appear during the last week in April and the first week in May. The workers run about on the soil in the hot sun as fierce hunters of small insects (Aphids, minute Heteroptera, etc). As they are extremely pugnacious even toward individuals of the same species from other nests, and as I have never found them nesting with *Monomorium minimum*, though this species is very common in the same localities, I believe, with Forel, that Pergande's observation must be quite exceptional or may even involve some misinterpretation.

0. Leptothorax (Dichothorax) floridanus Emery.

L. (*D.*) *floridanus* Emery, Zool. Jahrb., Abth. f. Syst., VIII, 1894, pp. 318, 324. ☿.

According to Emery, the worker of this species (Pl. XII, figs. 24 and 24*a*) differs from the preceding in the following characters: The body is more shining, the epinotum smooth and shining above, the mesoëpinotal constriction punctulate, subopaque, the petiolar node is narrower, and not impressed above, the postpetiole is hardly ⅓ again as broad as the petiole and proportionally narrower than in *Pergandei*.

Type locality: Florida (Pergande).

Additional locality: North Carolina (Forel).

The differences between the two *Dichothorax* are so slight that Emery suspected *floridanus* to be merely a subspecies of *Pergandei*. I am myself strongly of this opinion, but as I have seen only a single specimen of *floridanus*, kindly given me by Prof. Forel, I hesitate to reduce this form to subgeneric rank. In my specimen the petiolar node is very decidedly convex when seen from behind, and the epinotal spines are longer and more curved than in any of my specimens of *Pergandei*. In other respects I can see no differences of importance. Color, pilosity and sculpture are the same in both forms.

Explanation of Plate XII.

Fig. 1.—*Leptothorax muscorum* Nylander. Switzerland. In this and the following figures only the profile view of thorax and pedicel (petiole and postpetiole) of the worker are represented. All the figures are from camera lucida drawings.

Fig. 2.—*L. muscorum* var. *sordidus* var. nov.

Fig. 3.—*L. acervorum* Mayr. Switzerland.

Fig. 4.—*L. acervorum* subsp. *Canadensis* Provancher.

Fig. 5.—*L. acervorum* subsp. *Canadensis* var. *Yankee* Emery

Fig. 6.—*L. Emersoni* Wheeler.

Fig. 7.—*L. Schaumi* Roger.

Fig. 8.—*L. fortinodis* Mayr.

Fig. 9.—*L. longispinosus* Roger.

Fig. 10.—*L. curvispinosus* Mayr.

Fig. 11.—*L. curvispinosus* subsp. *ambiguus* Emery.

Fig. 12.—*L. curvispinosus* subsp. *rugatulus* Emery.

Fig. 13.—*L. curvispinosus* subsp. *annectens* subsp. nov.

Fig. 14.—*L. Schmittii* sp. nov.

Fig. 15.—*L. nitens* Emery.

Fig. 16.—*L. texanus* sp. nov.

Fig. 17.—*L. tricarinatus* Emery. (After Emery.)

Fig. 18.—*L. neomexicanus* sp. nov.

Fig. 19.—*L. obturator* sp. nov.

Fig. 20.—*L. nevadensis* sp. nov.

Fig. 21.—*L. terrigena* sp. nov.

Fig. 22.—*L. Andrei* Emery. (After Emery.)

Fig. 23.—*L.* (*Dichothorax*) *Pergandei* Emery. 23*a* node of petiole seen from behind.

Fig. 24.—*L.* (*Dichothorax*) *floridanus* Emery. 24*a* node of petiole seen from behind.

following paper anticipates a more elaborate descriptive cata-
of the Vicksburg fossils which the author has in view, and it is
led that the species here described as new shall be figured with
hers when that is published. It will be sufficient to state that
all the species here named for the first time are well known, and
ented in every collection from Vicksburg, Red Bluff or Jackson,
an be considered in any way complete, and there can be but little
of their ready identification from the diagnoses, comparative
erwise, which it is thought are drawn up with sufficient fullness
ccuracy for that purpose.

PELECYPODA.

a laqueata n. sp.

filosa Con. (Am. Jour. Conc., I, p. 145; nomen præoc.).

fers from the species named *perdubia* by De Gregorio; at least
mparing Vicksburg specimens with those from Red Bluff, I find
he latter form is shorter and differs greatly in sculpture in the
nal region. The true rugæ do not begin for a considerable dis-
from the beak in the Red Bluff form, this region being smooth
bly wrinkled, whereas in the Vicksburg species the rugæ begin
near the beaks, and the latter are more strongly gyrate. As the
burg species is distinct I would propose the name given to it in
script by Conrad. *C. laqueata* is a small species, never materi-
xceeding 6 mm. in length by 5 in height, the posterior flattened
e feebly delimited, the bounding line being rounded and not cari-
the rugæ are comparatively coarse ventrally. It is confined to
pper marl and represented in the lower limestone by a variety
g much finer rugæ.

of Lea, being shorter and relatively higher, and it is probably a true *Corbula*.

Under his description of *Corbula aliformis* (*Am. Journ. Conc.*, II, p. 76), Conrad remarks that "this shell belongs exclusively to the Shell Bluff group and is very distinct from *C. alta* of the Vicksburg group." This statement is difficult to comprehend as *C. aliformis* has been found in abundance by Mr. C. W. Johnson in the bluff bordering Mint Spring Bayou, at Vicksburg, at a point only a few feet removed in elevation or horizontal distance from the pocket of sandy clay in which I have taken the true *C. alta* plentifully. It is presumable, therefore, that both these species existed contemporaneously in the Lower Vicksburg. They are both completely unknown from the Upper Vicksburg marl. There is no reason to suppose that other species of this same subgenus of *Corbula* (*Tiza* De Greg.) may not exist at Vicksburg, and in fact I have a single valve that seems to indicate a third species, much more equilateral than the others.

The small *Mactra* occurring in great abundance in the Lower Vicksburg is a different species from *funerata*, which occurs only in the upper marl. It is probable that the former, which is much more inequilateral, may be the one named *inæquilateralis* by Meyer (*Bull.* 1, *Geol. Surv. Ala.*, p. 82), although the figure is rather poor. It is singular that the corresponding species occurring in the Jackson is the counterpart of *funerata* from the Upper Vicksburg, and differs decidedly from the Lower Vicksburg species.

In the Conrad Catalogue (*Am. Journ. Conc.*, 1865) there are two species which appear to have been originally named *Psammobia mississippiensis*, one under the genus *Gari*, on page 4, the other under the genus *Abra*, on page 5; the references seem to show that they were separately described and figured. The species *Abra mississippiensis* is the only one of which I can find the type. It is broadly oval, but slightly inequilateral and of moderately large size, relatively higher in form than *Abra perovata*, with which it occurs very abundantly in some parts of the Lower Vicksburg. The *Gari mississippiensis* (*l.c.*, p. 4) I cannot place and there appears to be no type in the Conrad collection.

There seems also to be no type of *Tellina perovata* Conrad, and I have not been able to identify this species from the material in my cabinet. In the list referred to, the locality "Claiborne" is attached to this species, but probably in error. The *Abra protexta* of Conrad, of which also no type can be found, is very abundant in the Lower Vicksburg, to which it is entirely confined; but it is a *Tellina*

near *vicksburgensis*, if I have identified it correctly from the published drawing, the latter being about twice as large as any of my specimens, but agreeing perfectly otherwise.

Tellina pilsbryi n. sp.

There is an undescribed *Tellina* occurring in large numbers in the Lower Vicksburg, to which I take pleasure in giving the above name in honor of Dr. H. A. Pilsbry, of Philadelphia. It is strongly inequilateral, trigonal, with the ventral edge rounded; rather thick in substance, compressed, the anterior and posterior sides broadly rounded, the surface equally declivous and convex toward the edges and not more abruptly declivous along the anterior edge; it is strongly marked with fine, very close-set concentric striæ throughout. The lateral teeth of the left valve are large and strongly developed, those of the right obsolescent. The larger cardinal of the left valve is subbifid. The length of a nearly full-grown valve is 9 mm.; height about 7 mm.; beak about 2 mm. in front of the median line. The lunule is small and slender.

Lucina vicksburgensis n. sp.

Occurs in the Lower Vicksburg in great abundance. This species is subequilateral, suborbicular, rather compressed, the beaks somewhat high and acute, the adjacent anterior sinus small and deep, the lunule small and deep-set and but little more than twice as long as high as a rule. The surface is covered throughout with strong concentric raised lines which are close-set and low, but becoming strongly lamelliform on the anterior and posterior dorsal declivities, the dorsal edge being rendered rough spiculose and uneven thereby. Cardinal tooth of right valve very oblique. Length 7½ mm.; height 7½ mm. It grew somewhat larger than the type above described, but never exceeded this length by more than about 2 mm. It might be considered closely allied to the Jacksonian *Cyclas curtus* of Conrad (*Am. Journ. Conc.*, I, p. 139), as the posterior side is noticeably more truncate than the anterior, were it not for the fact that *curtus* is described as "ventricose," a term which could not possibly be applied to *vicksburgensis*.

Lucina scopularis n. sp.

Red Bluff formation. Approaches *vicksburgensis* very closely, being orbicular and only moderately convex, but it is a little smaller and the concentric lines are finer, relatively less close-set and more lamelliform, becoming still more strongly so on the anterior and posterior dorsal declivities, though relatively less strongly so than on the corresponding parts of *vicksburgensis*. It differs principally

from the latter in the form of the anterostral sinus, which is longer and more transverse in outline, in the form of the lunule, which is larger and very much more elongate, and in the cardinal tooth of the right valve, which is here scarcely at all oblique, being almost perpendicular to the hinge line. In both species the laterals are moderately developed and the ventral edges smooth internally without trace of crenulation. Length of a moderately large specimen 7 mm., height 6.2 mm. The anterior and posterior sides are almost equally and very broadly rounded. This species is very slightly more inflated than *vicksburgensis*. There is a variety which is very abundant in the Jacksonian of Moody's Branch.

In the Conrad collection the only species of *Lucina* that I could discover is the largest form occurring at Vicksburg—moderately convex, very thin in substance, with feeble hinge and nearly smooth surface. The label attached states that this is *Lucina perlevis*. This is, however, the species which was subsequently described under the name *mississippiensis*. There is some confusion here.

Venericardia vicksburgensis n. sp.

The larger *Venericardia* of the Vicksburg differs specifically from the one occurring so abundantly in the Jackson—named *diversidentata* by Meyer—and also *rotunda* of the Claiborne, in having very much fewer radiating ribs, these being only 19–20 in number. It is found only in the lower limestone, and attained a length of 22 mm. or more. It occurs also at Red Bluff.

Cardita aldrichi n. sp.

Lower limestone at Vicksburg occurring in considerable abundance. It is only moderately convex, inequilateral, with about 15 broad, feebly convex, approximate radiating ribs. The longer ribs, behind the middle, are more notably wide and separated throughout their length by scarcely half of their own width. The anterior lateral hinge tooth is distinct. The length of a specimen rather more than half grown is 5.5 mm., the height 4.5 mm.

Arca invidiosa n. sp.

From the Red Bluff formation of Mississippi I have before me specimens of a small *Arca*, probably allied somewhat to the Claibornian *rhomboidella* of Lea. It is subrhomboidal, very inequilateral, moderately inflated, broadly rounded ventrally, the anterior and posterior sides oblique, the former rounded, the latter longer and nearly straight. The beaks are rather broad, moderately elevated above the hinge-line, bisected by a feeble depression which becomes obsolete ventrally.

The hinge-line is straight externally, broadly feebly arcuate internally, the line of teeth more than three-fourths as long as the shell, the lateral teeth becoming longer and strongly oblique. The space between the beaks and the hinge-line in flattened, nearly smooth except some fine, close-set parallel lines of growth, but at the posterior end there are some coarser parallel and feebly oblique lines. The radial ribs are 28 to 31 in number, rather coarse and separated by much less than their own widths, except in the feebly depressed area radiating from the middle of the beaks where they become finer and relatively much more widely separated, and generally with one fine intermediate rib between them in this region toward the ventral margin only; the ribs also become smaller but very close-set posteriorly in the flattened area toward the hinge-line. The surface posteriorly at an angle of about 30 degrees with the hinge-line is convex, becoming rapidly declivous and explanate to the latter. The muscular scars are rather deep. Lines of growth produce feeble transverse and rather widely separated nodules on the ribs generally becoming obsolete posteriorly. The length of a moderately large individual of this species is 11.5 mm., the height 6 mm.

Arca delicatula n. sp.

Occurs in the Lower Vicksburg limestone in great abundance. It may be regarded as a homologue of *invidiosa* and is doubtless one of the smallest known members of the family. It is elongate, very inequilateral, obliquely parallelogramic, moderately inflated, becoming flattened posteriorly toward the hinge-line, the latter long, thin and straight, the teeth small. The space between the hinge-line and the beaks rather low, flat and smooth or nearly so, narrowing very gradually posteriorly. The umbonal impression, with its diminished ribs, is nearly as in *invidiosa* and many other species. The ribs are some 28 in number, relatively moderately coarse, being generally separated by nearly their own widths, flattened. Length of a moderately large valve 6 mm., height 2.6–2.8 mm.

It is somewhat singular that no reference has been made to the very different sculpture of the right and left valves of *Arca lesueuri* Dall (*mississippiensis* Con.). The left valve has the diverging ribs double, the pairs being much more close-set than the single and smaller ribs of the right valve. It results from this that the left valve is much the stronger and more frequently preserved intact.

Arca vaughani n. sp.

While mentioning the genus *Arca*, it may be appropriate to allude to a species, quite common in the Lower Claiborne at St. Maurice,

La., and allied somewhat to *rhomboidella* Lea. It attained a length of more than 20 mm., with a height of 12 mm. or more, obliquely rhomboidal, moderately inequilateral, rounded anteriorly and posteriorly and broadly rounded ventrally. It is moderately inflated, the radiating concavity at the middle of the umbones almost obsolete and having merely slightly wider intervals between the ribs, the latter 41–43 in number. The hinge-line is long and straight, the teeth becoming larger and very oblique laterally but well developed throughout, with their sides finely ribbed, giving to each tooth a bipectinate appearance. The area under the beaks is ample and broadly, divaricately striate. This species differs from *rhomboidella* in its much larger size, more numerous ribs, rounded ventral edge and many other characters, and may be named *vaughani*. A fair illustration of it was given by Mr. Vaughan (*Bull. Geol. Surv.*, 142, Pl. III, fig. 8), in whose honor it is named. A modification of the true *rhomboidella*, but still smaller in size, also occurs sparingly at St. Maurice.

SCAPHOPODA.

Dentalium strenuum n. sp.

In the Upper Vicksburg there are two large species of *Dentalium;* one—*D. mississippiense* of Conrad—is moderately large, gradually tapering throughout its length, feebly, evenly arcuate, having about 12 well-marked raised threads which become doubled or sometimes quadrupled in number anteriorly, but generally almost effaced at the mouth. A moderately large specimen measures 47 mm. in length by 4.6 mm. in maximum diameter. The other species, which may be named *strenuum*, is much larger, nearly straight, but becoming more rapidly arcuate and also more distinctly tapering in form near the posterior end. The ribs are some ten in number at the smaller end, becoming generally quadrupled in number at the mouth, where they still remain very distinct. The substance of the shell is much thicker, being frequently 1.2 mm. through the walls near the middle. The notch at the smaller end is nearly as in *mississippiense*, but generally deeper and more acute. The largest entire specimen in my cabinet measures 67 mm. in length by 6.3 mm. in maximum diameter, but I have seen fragments measuring more than 7 mm. in diameter and which represented examples probably not much less than 90 mm. in length.

Dentalium opaculum n. sp.

Occurs in the Lower Vicksburg in very great numbers. It is smaller than *mississippiense*, somewhat less arcuate, gradually tapering, notably uneven in growth and frequently more or less contorted at

various points in its extent, smooth but dull in luster, devoid of any trace of elevated ribs or threads except toward the smaller end, where some 12 to 16 faintly raised subequal lines become visible. The posterior notch is very feeble and broadly angulate, much feebler than in either of the preceding species. A moderately large example measures 40 mm. in length by 4 mm. in diameter, but the latter dimension occasionally attains 4.5 mm., which would represent a rather large individual.

Dentalium zephyrinum n. sp.

The commonest species at Red Bluff, closely resembling the preceding in general size, form and slight irregularity of growth, but the longitudinal threads are distinct throughout the length and of a different form, being wider and flat, equal, about 16 in number, very strong posteriorly, becoming finer and feebler anteriorly where one or two feebler intermediate threads become visible. The posterior notch is well marked, not broadly angulate but generally rather deeper than wide. The length of the largest individual before me is 41 mm., with a maximum diameter of 4.2 mm.

Dentalium polygonum n. sp.

This species also, from Red Bluff, is still more slender, and is peculiar in being a perfect heptagon in cross-section near the smaller end, the angles of the polygon being minutely elevated, forming fine but conspicuous longitudinal threads, which remain distinct to the larger end; the intervals soon acquire two to four finer threads which never become as conspicuous as the primary ribs. The notch is not present on the truncated apex of the only specimen before me. Length 33 mm., width 3.2 mm.

GASTROPODA.

The *Fusus mississipiensis* of Conrad is a *Latirus* allied to *protractus*, having the columellar folds evident though rather feeble. It differs in the entirely rounded outline of the whorls, there being no wide double band or collar below the suture as in that species. It is moderately abundant in the upper marls.

Fusus vicksburgensis is very rare and also occurs solely in the upper marls. My specimens are all fragmentary, partially decorticated and decomposed. Its broad flat lyræ easily distinguish it and the nucleus and nepionic whorls are also peculiar.

The Vicksburg type of *Clavella* differs from that of the Eocene horizons in having a small conoidal nucleus. They are probably generically different. As far as I have been able to discover there are

at least two species in the Vicksburg, both confined to the lower horizon.

There are several species of *Pleurotoma* in the Vicksburg and subadjacent horizons allied more or less closely to *servata* Con., and apparently neglected or overlooked hitherto in our literature, but which can be distinguished readily by brief comparative descriptions. In *servata* the nucleus is smooth, elevated, acute and of 3 or 4 whorls, the last whorl gradually acquiring a few riblets which become by degrees the 7 or 8 large rounded ribs of the body whorls. There is no appearance of a subcentral revolving carina on the whorl adjoining the nucleus, and on each of the more recent whorls there are generally 3 coarse revolving lines thickened on the ribs, with numerous very fine close-set intermediate threads, all occupying about lower half of the whorl. Just below the suture there is a conspicuous thickened collar, immediately below which there is a deep revolving concavity, the surface thence expanding to the uppermost of the coarse revolving lines, the entire surface between the latter and the collar having fine subequal and rather close-set lines. The aperture and canal together constitute about three-sevenths of the total length of the shell.

Pleurotoma vicksburgensis n. sp.

This species occurs plentifully in the Vicksburgian beds, accompanying *servata* and generally confounded with it. It usually attained a a little larger size and stouter form, and may be distinguished at once by the fact that the whorl immediately adjoining the nucleus has a strong revolving line below the middle, thickened on the ribs and accompanied by a close-set smaller revolving line immediately above it. The larger whorls generally acquire two other coarse, though much smaller revolving lines, one above and one below the two mentioned, and also finer intermediate threads. Just below the suture the elevated collar is not quite so prominent as in *servata*, and, instead of the abrupt concavity adjoining, the surface is almost evenly concave and rapidly expanded to the system of coarse revolving lines referred to, this surface being also finely, evenly lyrate. The nucleus is much shorter than in *servata*, consisting of between two and three whorls, and is not higher than wide. The aperture and canal are nearly as in *servata*. One of the larger specimens before me measures 27 mm. in length by 7 mm. in width. The double carina of the nepionic whorls remains throughout the most conspicuous feature of the revolving sculpture, the lines becoming gradually more nearly equal and more widely spaced, with the dilatations on the ribs much more pronounced than in *servata;* the ribs, also, are much more broadly

rounded than in that species and become obsolete in the posterior concave area of the whorls. A specimen in the Conrad collection is marked "*servata* var.?"; it is deprived of the nucleus and adjoining whorls. Both this species and *servata* occur also in the Lower Vicksburg, but in slightly modified forms.

Pleurotoma oblivia n. sp.

This is a Red Bluff species somewhat allied to *servata*. It resembles *servata* in general form and conformation of the nucleus, nepionic whorls, aperture and canal, the elevated smooth nucleus of three or four whorls and nepionic spire whorls being formed in the same way, but the ribs are narrower, more strongly rounded, much more elevated and only about six in number, strongly marked throughout the length of the whorl and only becoming extinct at the rather fine sinuous collar just below the suture. The revolving sculpture consists of eight or nine coarse lyræ, more dilated on the ribs, the first three less coarse and subequal, those in anterior two-thirds of the whorl generally with one fine thread intermediate. Length 22 mm., width 6.5 mm. It may be readily distinguished from *servata* by the fewer, narrower and more elevated ribs, more equal revolving lines throughout the length of the whorls and absence of any defined posterior flattened or concave area on the latter.

Pleurotoma evanescens n. sp.

In the Jacksonian of the Kimbrel Beds, outcropping on the Red River a few miles below Montgomery, occurs another *Pleurotoma*, rather closely resembling *servata* in general form, but widely distinct in sculpture and even more elongate in form. The nucleus is smooth, rather higher than wide and has about three whorls, the subsequent whorls mutually subsimilar, each having scarcely six large, though feebly elevated, oblique ribs. The collar below the suture is moderately wide but obtuse and low, not sinuous, and, immediately below it, the surface is feebly concave and moderately rapidly expanded to the middle, where each whorl is obtusely tumid and prominent, the surface thence gradually declivous anteriorly to the suture. The low feeble oblique ribs become wholly extinct in the concavity, occupying almost posterior half of each whorl. The sculpture is very fine and feeble, consisting of relatively broad but very feebly elevated, flat, revolving lyræ, which are very close-set and subequal, mutually separated by a single very fine thread of similar character. The entire sculpture is so feeble that it is very apt to be entirely effaced by water wearing. Length of the largest of the three specimens

before me 32 mm., width 8 mm. On the part of the larger body whorls below the shoulder, the revolving lyræ become more widely separated, with three fine threads intermediate, as a rule, but the lyræ are always flattened and in more or less low relief.

Pleurotoma hilgardi n. sp.

From the Jacksonian of Moody's Branch, I have two species which appear to have been confounded with *servata*, though differing radically therefrom in the structure of the nucleus. One, named as above, is almost similar to *servata* in size, form and in the number and form of the slightly oblique rounded ribs, but has the raised revolving lines some eleven or twelve in number, subequal in size among themselves and becoming only slightly larger on the anterior parts of the whorl. The nucleus differs very radically from that of *servata* or *oblivia*, being small, obtuse and composed of only one and a half to two whorls. The canal also is decidedly shorter. Length 16 mm., width 5 mm.

Pleurotoma collaris n. sp.

This is the second species from Moody's Branch referred to under the preceding description. It is stouter, with a still shorter canal, the aperture and canal together constituting about two-fifths the entire length of the shell. The nucleus is small, obtuse and of about two whorls. Body whorls about seven in number, each with some seven or eight obtuse ribs and a wide and strongly elevated conspicuous collar just below the suture, the upper surface of the collar declivous to the suture and having two close-set revolving striæ, the lower part acutely elevated. The surface below the collar is deeply concave, then rapidly expanding to the posterior of the three strong raised lines which occupy about anterior half of the whorl. The concavity is marked with many very fine close-set revolving lines and the spaces between the three large lyræ referred to also have each about three fine lines. Length 17 mm., width 6 mm.

Pleurotoma amica n. sp.

Of the species allied to *rotœdens* and *tenella*, there are several forms in the Red Bluff stratum. One of these, named as above, is somewhat stout, sculptured nearly like *rotœdens*, excepting that the concave and rapidly expanded surface immediately below the sutural collar scarcely ever acquires more than about two fine threads which occupy its median parts, while in *rotœdens* there are numerous fine threads at this part of the larger whorls. The nucleus in *amica* is larger than in *rotœdens*, and there are generally about three of its whorls covered with fine acutely raised riblets, instead of about two whorls, as

in *rotædens*. The strongly elevated median revolving keel is similar to that of *rotædens*, and double, but the nodules are coarser. Length 14.5 mm., width 4.5 mm. The corresponding dimensions of an equally well-grown specimen (that is, of six body whorls) of *rotædens*, from the Upper Vicksburg, are 11 by 2.8 mm. *Amica* may be regarded as a probable ancestor of *rotædens*.

Pleurotoma ancilla n. sp.

The archetype of *tenella* in the Red Bluff may be thus named. It is nearly similar in form to *tenella* but smaller, the nucleus large and well developed, of nearly five whorls, approximately the last two having numerous fine acute riblets; it is higher than wide and acute. The subsequent whorls have a broadly obtuse revolving prominence just below the middle, which is closely ribbed, the ribs longitudinal and rounded; collar below the suture consisting of two approximate subequal and slightly uneven revolving lyræ; space between the collar and median ribbed tumidity moderately expanding and having three or four fine subequal lines; just below the median tumidity there is a fine irregular line. Aperture and canal together short, scarcely more than a third the length of the shell. Length 13 mm., width 4 mm. The specimens measured has about six body whorls.

Pleurotoma plutonica n. sp.

Not rare in the Lower Vicksburg limestones. This species is rather slender, perfectly smooth and polished throughout, with scarcely a trace of revolving sculpture except on the beak, where there are some oblique widely spaced striæ. The nucleus is smooth, acutely ogival, higher than wide and of about four whorls. The subsequent whorls have each about eight low rounded oblique ribs, which become obsolete in a revolving concavity below the suture. The first three, or thereabouts, of the body whorls have a rather pronounced, though obtusely rounded, swelling adjoining the suture beneath, but this is gradually lost on the larger whorls, these having but feeble traces of a raised band at the suture, the latter being a very fine, slightly sinuose and feebly impressed line. The canal is well differentiated from the aperture, and the two combined constitute about three-sevenths of the total length of the shell. Length 12 mm., width 3.7 mm. Another specimen, represented by the spire alone, indicates that the species may attain a length of fully 15 mm. or more. There is no trace of this species in the upper marls.

Pleurotoma intacta n. sp.

Another species, equally well defined, may be named as above. It is small, moderately stout, fusiform, the aperture and canal, which

are not very strongly differentiated, together constituting nearly half the entire length of the shell. The nucleus is as wide as high, consisting of about three whorls, smooth but gradually acquiring the fine riblets which become the eight or nine rather narrow and subacutely elevated oblique ribs of the subsequent whorls, the latter short, about four in number in the largest specimen before me, the ribs angular in profile from base to apex of the whorl, with point of maximum elevation just below the middle of the length and becoming obsolete just below the pronounced uneven and closely duplex collar margining the suture beneath. Each whorl has six or seven coarse, subequal and closely approximate flattened or slightly convex lyræ, those in lower half slightly coarser than the posterior three, and that at the middle slightly thickened at the summits of the ribs. Length of the largest in an extended series 7 mm., width 2.5 mm. This species occurs only in the upper marls at Vicksburg and is common.

PHANDELLA n. gen.

This genus occurs, in the Upper Vicksburg marls, and appears to have no closely allied living descendant, although related perhaps to *Daphnella*. The shell is minute, and the animal apparently existed the greater part of its life in the nuclear stage, there being no example which I have seen, out of a considerable series collected, possessing more than between one and two body whorls. The nucleus is relatively large though evenly conical, pointed, consisting of from five to six whorls which are exquisitely sculptured in two systems of very minute lines crossing each other at an angle of about 45°, producing an appearance very much like the engine-turning frequently engraved upon a watch.

There are before me three species, distinguishable among themselves by very clearly marked characters, but at the present time I will only briefly outline the most abundant of the three, which may be regarded as the type of the genus.

Phandella nepionica n. sp.

This species has about one and a half body whorls, which are together about twice as long as the nucleus, polished and completely devoid of revolving sculpture, having, however, about ten sharply elevated longitudinal or slightly oblique ribs, which become abruptly declivous posteriorly and obsolescent near the suture. The nucleus has about five whorls; the canal is rather short and there is a fine raised collar margining the suture beneath, which line may also be observed to

mutually separate the larger of the nuclear whorls. Length 2.25 mm., width 1.2 mm. Many specimens.

Drillia harmonica n. sp.

A well-defined new species, quite rare in the Lower Vicksburg, and not yet found in the upper marls. It is rather stout, the spire apparently narrowing somewhat more rapidly toward apex. Nucleus simple and composed of three or four whorls. The subsequent whorls are rather short, each with some eight or nine strongly marked rounded ribs, longitudinal in direction or nearly so, and generally in line from one whorl to the next; they extend nearly throughout the length of the whorl, becoming obsolete only in the narrow revolving concavity below the ante-sutural elevated collar, which is rather thick and conspicuous and marked posteriorly with one or two striæ. Each whorl has some seven or eight nearly equal revolving lyræ, those near the middle mutually separated as a rule by a finer line. The aperture is rather wide, the canal very short, the two together but little more than a third of the total length, the callus near the posterior angle of the aperture tumid and conspicuous. Length 11 mm., width 3.7 mm. I had confounded this species with *mississippiensis*, of Conrad, until a recent inspection of the type of the latter shows that it is very different; *mississippiensis* is very stout much larger, with the revolving concavity below the sutural collar very wide, constituting about half the entire length of the whorl; the short, broadly rounded ribs are confined to anterior half of the whorls and are obsolete in the posterior concavity. The specimen is somewhat water-worn, so that the sculpture is not distinct, but there are apparently revolving raised lines which distinguish the species at once from the smooth and otherwise very different *eboroides*. The type seems to be unique.

Scobinella pluriplicata n. sp.

In the genus *Scobinella*, of Conrad, it should be stated that the species occurring at Red Bluff is distinct from *cœlata* of the Upper Vicksburg marls, and I would propose the above name for it. This species is much larger than *cœlata*, with a relatively more elongate and less rapidly acuminate spire, and differs also in sculpture. In *cœlata* there is a broad flattened duplex collar extending from the suture anteriorly for about a fifth the length of the whorl, the surface then concave to well below the middle, generally with about three revolving lines at the bottom of the concavity, the middle one of which is nodulose; the surface from the concavity to the lower limit of the

whorl is more prominent, flattened and divided into two coarsely nodose sections by a fine stria. In *pluriplicata* the whorls are relatively much more elongate, and, from the suture for about one-sixth of the length, are flattened; the next sixth of the length is occupied by a small concavity containing a nodulose line, which is even more prominent than the preceding flattened collar; the surface thence to the anterior limit of the whorl, occupying fully two-thirds of the length, is still more elevated but flattened, cylindrical and divided into about four nodose rings by three rather coarse equidistant revolving grooves. The canal is more prolonged and more obconic than in *cœlata*, and the plications of the columella number some four to five. Length of a specimen of about seven body whorls 35 mm., width 9.5 mm. Length of a specimen of *cœlata* of the same number of whorls 21 mm., width 6.5 mm. *Pluriplicata* occurs also at Byram's Ferry. The Lower Vicksburgian at Vicksburg has not yet yielded a trace of the genus.

Scobinella famelica n. sp.

Very slender and elongate, the aperture narrow, scarcely at all wider than the canal, from which it is but feebly differentiated, both together constituting but little more than a third of the total length of the shell. The nucleus is rather small, of about three whorls, with its summit obtuse. Subsequent whorls each with a prominent double collar subjacent to the suture and a broad obtuse and strongly elevated revolving keel, fully a third as wide as the length of the whorl and divided into two subequal rings by a revolving groove, situated below the middle of the whorl; this duplex ring is obliquely and coarsely nodose. In the concavity between the collar and the elevated keel there are two or three fine revolving lines, the posterior of which is finely and more or less evenly nodulose. The anterior margin is a fine line on a level with the duplex ring and separated therefrom by a narrow deep concavity. Columella with six or seven rather unequal, close-set oblique folds, forming a slightly tumid columellar band as wide as the distance separating it from the posterior angle of the aperture. Length about 25 mm., width 4.5 mm. It occurs exclusively in the Upper Vicksburg marl and is rare.

Scobinella macer n. sp.

Upper Vicksburg. This species resembles the preceding in general form and sculpture but has only two folds on the columella. These folds are strong, subequal and do not seem to be attended by any adventitious plicæ. This species is elongate and very slender, the nucleus simple and of about three whorls. Each of the subsequent

whorls has a broad, moderately elevated double collar subjacent to the suture and a strongly elevated, obtuse and nodose double carina at a third of the length from the anterior margin, the deeply concave intermediate surface having a single strongly beaded line along the middle and a few other very faint and obscurely irregular revolving threads. The lower margin is moderately elevated, the surface thence to the large double carina concave. The spire before me consists of seven body whorls and is 10 mm. in length and about 3.5 mm. in width at base. The remainder of the shell is missing, it being very rare and represented thus far only by fragments.

The genus *Scobinella*, of Conrad, is probably valid, but contains species having anywhere from two to six or seven columellar folds.[1] They hold together very well in general type of sculpture and depart materially in a great many characters from *Cordieria*. The genus *Cordieria* does not occur in the American Eocene fauna and there is considerable confusion in the literature concerning it. Cossmann states that the first two of the species originally placed in *Cordieria* by Rouault are really *Borsonia*, and, assuming the third species as the type, gives an illustration of a "plesiotype" which would bear considerable resemblance to *Latirus* were it not for the obsolete canal. He also states that the embryo of *Cordieria* is paucispiral with subglobular apex, which does not agree with our species, such as *biconica*, *plicata* and *ludoviciana*, and another genus may have to be made for these. In *Scobinella* the sinus is well developed, but in *Cordieria* and the American analogues named above it is very feeble, so that on this ground as well as many others the association of *Cordieria* and *Scobinella* by Tryon was entirely unjustifiable. In fact the Pleurotomid affinities of some of the forms assigned to *Cordieria* stand in need of fuller confirmation. *Turbinella perexilis*, of Conrad, is a species having two strong columellar folds and is of uncertain relationship. We do not appear to have the true *Borsonia* in the American fauna, and *Borsonia plenta*, of Harris (*Proc. Acad. Nat. Sci. Phila.*, 1895, p. 63), cannot properly be referred to that genus. Besides the species from Red Bluff and Vicksburg, referred above to *Scobinella*, this genus will include *Pl.* (*Eucheilodon*) *reticulatoides* Harris (*l.c.*, p. 63), from the Lower Claiborne of Texas. The genus *Eucheilodon*, as represented by *crenocarinatum* of Heilprin, differs from *Scobinella* in the form of the nucleus, this being very large, probably indicating a slightly different line of descent.

[1] If *Pleurotoma* (*Moniliopsis*) *elaborata* Con., be included, as I believe to be proper, the genus will have also species without columellar folds as is the case with the genus *Microdrillia* to be described below.

MICRODRILLIA n. gen.

A number of minute Pleurotomids, including *infans* and *cossmanni* of Meyer, and *harrisi* of Aldrich, have been referred to by Cossmann under the names *Asthenotoma* and *Scobinella*, by Harris under *Mangilia*, by Aldrich under *Glyphostoma*, and by Meyer, Vaughan and others under *Pleurotoma* in its broad sense. They are all very small and characterized by a well-developed, multispiral, closely coiled embryo, having one to three of its basal whorls costulate, few body whorls which are wholly devoid of costæ but spirally carinate, the retral sinus relatively large, circularly rounded and close to the suture, the aperture oblique, columella callous, with or without plications, and the canal short or subobsolete.

The genus *Microdrillia* differs from *Asthenotoma*, to which *cossmanni* was referred by Cossmann, in the structure of the embryo, and, especially, in the position of the retral sinus, which in *Asthenotoma* corresponds in its greatest depth with the median line or periphery of the whorls. In fact, there is only one American species known to me which can properly be assigned to *Asthenotoma*, this being the *Pl. texana* of Gabb. *Microdrillia* is much more closely related to *Glyphostoma*, as suggested by Aldrich, but is not at all allied to *Mangilia*. It appears to have become wholly extinct in the Oligocene or Lower Miocene. The species were numerous and individually abundant, especially in the mid-Eocene of the Lower Claiborne, and those before me may be readily identified by the following table:

Columella without folds, ... 2

Columella with numerous rather widely and evenly spaced folds; shell thick and heavy, the base angulate, not at all rostrate. 8

2—Shell rhomboidal in profile, thick and strong, the ante-peripheral part but little shorter than the entire portion behind the periphery of the body whorl; revolving carinæ very thick. 3

Shell more elongate, the ante-peripheral part always much shorter than the post-peripheral, thinner and more delicate, with relatively fine carinæ. . 4

3—Embryo small, evenly and broadly conical, of three smooth and one finely costulate whorls; body whorls four in number, each with three strong carinæ, the lowermost carina first appearing generally on the second or third whorl: lines of growth strongly marked, cancellating the body whorl; columella subumbilicate in the type. Length 4.5 mm.; width 2 mm. Jacksonian Eocene of Moody's Branch, Miss., . . . [*Pleurotoma*] *cossmanni* Meyer [*meyeri* Coss.]

Embryo similar in structure but much larger; body whorls generally not more than three in number, each with two very thick carinæ; columella not umbilicate in the specimens at hand; lines of growth very fine, scarcely noticeable. Length 2.8 mm., width 1.4 mm. Lower Claiborne Eocene. Vesey Creek, Lee Co., Tex. . . . . *solidula*, n. sp.

4—Peripheral carina at or above the middle of the whorls; concave fasciolar surface simple or with one or two fine simple revolving threads. 5

Peripheral carina below the middle of the whorls; beak well defined and rapidly acuminate; fasciolar surface with a conspicuously beaded thread; embryo with two or three smooth and about two costulate whorls; body whorls three or four in number. 7

5—Base of the shell distinctly rostrate; body whorls about four in number. Form stout, the spire whorls short, about three times as wide as long, with a subduplex subsutural collar and three other single carinæ, the fasciolar surface with two fine revolving threads; beak short and broad; lines of growth strongly marked; embryo well developed as usual, higher than wide, ovulate at tip, with three smooth and two costulate whorls. Length 5.7 mm., width 2.3 mm. Lignitic Eocene. Wood's Bluff horizon. *rostratula*, n. sp.

Base of the shell angularly acuminate, not at all rostrate; body whorls variable, but never exceeding four as far as known. 6

6—Embryo as wide as high, obtusely oval at tip, with three smooth and two costulate whorls; subsequent whorls four in number, each with one subsutural and three other equal carinæ; fasciolar surface without a revolving thread. Length 5.6 mm., width 2.25 mm. Lower Claiborne Eocene. St. Maurice, La. . . . . *robustula*, n. sp.

Embryo acutely conical, scarcely higher than wide, with three smooth and one costulate whorls; subsequent whorls not more than two in number in any of the three type specimens at hand, similar to those of *robustula*, but much more slender. Length 2.3 mm., width 1 mm. Lower Claiborne Eocene. St. Maurice, La. . . . . *minutissima*, n. sp.

Embryo larger and much more complex, evenly conical, as wide as high, with two small smooth whorls and three finely and closely costulate, the latter strongly convex near their basal margins; form rather stout; whorls two in number in specimens at hand, the fasciolar surface without a revolving thread. Length 3.9 mm., width 1.5 mm. Red Bluff Eocene. [*Pleurotoma*] *infans* Meyer

Embryo nearly one-half higher than wide, subcylindrical, rapidly pointed at tip, with three smooth and nearly three coarsely costulate whorls, the latter strongly and more medially convex; subsequent whorls not exceeding four in number, the fasciolar surface with a fine revolving thread; shell much more slender and elongate than in *infans*. Length of embryo alone 1.4 mm., width .8 mm. Upper Vicksburg Oligocene. . . . . . . *vicksburgella*, n. sp.

7—Beaded thread below the middle of the fasciolar surface, a finer simple thread between it and the subsutural carinule; granulations of the beaded thread fine but distinct. Length of a specimen of 3.5 body whorls 6.7 mm., width 2.6 mm. Lower Claiborne Eocene. St. Maurice, La. [*Pleurotoma*] *lerchi* Vgn

8—Spire more rapidly narrowed toward apex, the embryo very small, of three or four whorls, the lowermost apparently costulate; body whorls five to six in number, each with subsutural and submedian coarse equal carinæ and a third, finer and less conspicuous, between the latter and the base; concave fasciolar surface between the coarse carinæ with a fine median revolving thread; lines of growth well marked as usual; columella subumbilicate as a

rule. Length 6.5 mm., width 2.3 mm. Lower Claiborne Eocene. Moseley's Ferry, Burleson Co., Tex. . . . . *aldrichiella*, n. sp.

Spire evenly, conically acuminate, the body whorls never exceeding four in number; embryo always larger and well developed. 9

9—Revolving carinæ as in *aldrichiella*, very coarse; fasciolar surface with a more or less distinct revolving thread; embryo as wide as high, conical, acutely pointed, with three smooth and one costulate whorls; shell stout and thick. Length 5 mm., width 2 mm. Lower Claiborne Eocene. Elm Creek, Lee Co., Tex. . . . . [*Glyphostoma*] *harrisi* Ald.

Revolving carinæ very much finer; shell narrower and more slender; embryo well developed, higher than wide, acutely conical, with four smooth and one costulate whorls; fasciolar surface without a revolving thread; columella with four or more folds as usual in this group. Length of specimen with three body whorls 4.5 mm., width 1.5 mm. Lower Claiborne Eocene. Elm and Vesey creeks, Lee Co., Tex. . . . . *elongatula*, n. sp.

Revolving carinæ fine as in *elongatula*, the shell similarly slender, differing in having two costulate embryonic whorls, a fine revolving thread in the fasciolar surface and but two columellar folds; body whorls but two in number in the type. Length 2.3 mm., width 1 mm. Red Bluff Eocene. *biplicatula*, n. sp.

A species which is strikingly similar to the Lower Claiborne *harrisi* was figured by Cossmann (*Essais Pal. Comp.*, deux. liv., Pl. VI, fig. 35) under the name *Scobinella læviplicata* Gabb. It is said to have been found at Jackson, Miss., by Meyer, but I have seen no plicate species from that horizon. Cossmann's generic diagnosis of *Scobinella* is also drawn from this figured "plesiotype," and for this reason does not apply to the *Scobinella* of Conrad at all. The true *læviplicata* is a *Eucheilodon* and is perfectly synonymous with *reticulata* Gabb. The *reticulatoides* of Harris is, however, a true *Scobinella*, the name being therefore somewhat unfortunate as *Scobinella* and *Eucheilodon* are amply distinct genera.

Under the description of *Pleurotoma infans* (*Geol. Surv. Ala.*, Bull. I, p. 75) Meyer refers to a Vicksburg form under the name var. *brevis*. This form is really not described at all and must be considered a list name, it being simply stated that it is decidedly stouter than *infans*. Even this statement, however, will not apply to the *vicksburgella* defined above, which is more slender and elongate than *infans* and differs radically in the form and sculpture of the embryo.

Mr. Harris states (*Bull. Am. Pal.*, Vol. 3, p. 24) that the *Glyphostoma harrisi* of Aldrich is a synonym of *infans* Meyer. This is incorrect, as subsequently held by Mr. Aldrich; the two species are not at all closely related.

COCHLESPIRELLA n. gen.

The *Fusus nanus*, of Lea, belongs to a genus widely different from *Microdrillia*, but allied more closely to *Cochlespira* of Conrad. The genus, which will include also *insignifica* of Heilprin, which is not the same as *nanus* according to some very accurate drawings of the types very kindly lent me by Mr. Aldrich, and one or two undescribed Texan forms, may take the above name.

Conus scopularis n. sp.

In the Red Bluff deposit there is a *Conus*, about the size of the Vicksburgian *alveatus*, but with a much more depressed spire and differing also in sculpture to a marked degree. This species differs also from any of the forms found in the Jacksonian. It is rather broadly obconic in form, the exterior outline of the body whorl straight, becoming very broadly, feebly arcuate toward the shoulder, just below which there are some two or three close-set and very obsolete obliquely rugulose revolving striæ. The anterior oblique revolving striæ are very feeble, subobsolete and occupy lower third of the whorl. The oblique anterior columellar fold is feeble. Spire extremely short and flattened, not more than an eighth or ninth as long as the body whorl, the whorls flat, each with five strong revolving lyræ separated by equally large grooves, the arcuate lines of growth very distinct, producing a beaded or scabrous appearance. Length 28 mm., width 16.5 mm. The fine striæ on the face of the body whorl at the top and parallel to the acute shoulder angle distinguish this species at once from any in the adjacent horizons.

The species named *Bursa mississippiensis* by Conrad, in the list of 1865, is, in all probability, the young of *Triton conradianus* Ald., of the Red Bluff horizon. I have found this species in the Lower Vicksburg. *Bursa abbreviata* is, however, a distinct species, moderately abundant in the upper marl at Vicksburg, to which it is confined, as is also *Distorsio crassidens*. *Tritonopsis subalveata*, of Conrad, is confined to the Lower Vicksburgian, like *Bursa mississippiensis*.

Phos macilentus n. sp.

Phos mississippiensis, of Conrad, occurs in both horizons at Vicksburg, but does not occur at Red Bluff. The species of the Red Bluff formation, which has hitherto been confounded with it, may take the name indicated. It is much narrower and more elongate than *mississippiensis*. The ribs are more numerous, finer and not so nodulose at the points where they are crossed by the revolving sculpture. The revolving lines are subequal among themselves, finer than in *mis-*

sissippiensis and not so strongly alternating in size. Length of a specimen of six body whorls 14 mm., width 4 mm. *P. mississippiensis* seldom has more than five body whorls, and an average specimen measures 13.5 mm. by 5 mm.

Phos falsus n. sp.

I have before me a remarkable Red Bluff *Phos*, which may be named *falsus*. It is very much larger than *macilentus*, though nearly as slender. The nucleus is as in that species and *mississippiensis*, consisting of four whorls, the lowest of which is sculptured with very fine obliquely sigmoid riblets. The body whorls are six in number, with rather widely spaced longitudinal ribs, some eight in number, subequal among themselves on the first four whorls, but then becoming very widely spaced and finally completely disappearing, leaving the surface even; the revolving lines are distinct but not very coarse, and are mutually separated on the larger whorls by two or three fine, closely spaced threads. The type before me has a strong rounded varix on the sixth whorl and another forming the outer lip. Length 19 mm., width 6 mm.

Metula fastidiosa n. sp.

In the Red Bluff bed there is an apparently undescribed *Metula* greatly resembling *gracilis* Johnson, from the Lower Claiborne of Texas (*Proc. Acad. Nat. Sci. Phila.*, 1899, p. 75, Pl. II, fig. 3). This species, which may be named as above, has a smaller and more rapidly pointed spire than *gracilis*, and has a greater number of varices. The nucleus is simple, smooth, rather higher than wide, ogivally pointed and of about three whorls, the subsequent whorls five in number, broadly, evenly rounded at the sides in profile, each with a feebly elevated flattened varix, relatively rather wide, on which the longitudinal ribbing becomes obsolete and the revolving lyræ also obsolete except on the body whorl, where they continue uninterruptedly over the varix, which here becomes relatively still wider though so slightly elevated as to be scarcely definable. The ribs are small, and, from varix to varix on the spire whorls, about 32 in number; on these whorls the revolving grooves are about 10 in number, and, with the exception of the two posterior and one finer anterior, do not cross the ribs but appear as short excavated lines between them; on the body whorl, however, all the grooves cross the ribs but are reduced in width on their summits; the ribs on the body whorl are also somewhat changed in character, being notably less steep in cross-section on the side lying in the direction of the growth of the shell. The columella is thickened

anteriorly below the middle and the aperture and canal together are half as long as the shell. Outer lip with a plicate band parallel with the edge at a short distance therefrom. Length 15.5 mm., width about 6 mm.

Metula fragilis n. sp.

This is apparently the direct descendant of *fastidiosa* in the Upper Vicksburg marl and is a much larger species, with more numerous and relatively much finer and more close-set ribs; it is very thin and delicate in substance, very rare and always occurs in a fragmentary condition. From a fragment before me I am able to compute the diameter of the body whorl to be about 10 mm. The longitudinal riblets are at least 90 in number, and the revolving lines on the largest whorl of the spire about 20. No varices can be seen on the fragments before me. The revolving grooves are shallow, those near the base and apex of the whorls broader and more thoroughly obliterating the ribs. The ribs are broadly arcuate longitudinally. The length of the specimen at hand must have been at least 25 mm. The shell walls are composed of three layers, of which the inner, very thin, and the outer, thicker, are solid and amorphous in texture, the two separated by a very thin layer of prismatic structure having the fibres perpendicular to the surface.

Olivella affluens n. sp.

There are two very distinct species of *Olivella* occurring abundantly in the Vicksburg strata. One of these, which may be assumed to be the typical *mississippiensis*, has the nucleus small, of very few whorls and the nucleal sutures obliterated. The whorls of the spire are completely unexcavated along the anterior edge. The other species, named as above, is as common as *mississippiensis;* it is rather smaller, the nucleus being, however, much larger, very obtuse, composed of about three whorls having the sutures all distinct and impressed. Each whorl of the spire has a deep and clearly defined revolving groove at the lower margin, which is entirely wanting in *mississippiensis*. The anterior folds of the columella are less oblique than in that species. Length of a moderately large specimen, having four body whorls beside the nucleus, 14.5 mm., width 5.7 mm. The aperture is somewhat narrow, and is rather less than two-thirds the total length of the shell. The differences between these two species are at least subgeneric.

It would seem to me that *Fulgur spiniger* and *nodulatum*, of Conrad, are distinct species and not mere varieties of one. I have collected a number of specimens of *spiniger*, and there is no marked variability

to be perceived. *Spiniger* is confined to the Upper Vicksburg marl, while *nodulatum* has occurred thus far only in the Lower Vicksburg limestone. The latter differs in both form and sculpture from *spiniger*, but varies of course in the relative amount of shoulder exposed above the suture, as is generally the case throughout the genus. The form occurring at Red Bluff differs from *spiniger* in its larger size, rather more elongated form, feebler sculpture, less strongly differentiated whorls of the spire, and more feebly developed spines of the spire whorls, also in usually having traces of a fine subobsolete, remotely and minutely subnodulose line at some distance below the spinose shoulder line. It may not be more than a subspecies of *spiniger*, but resembles that species more closely than *nodulatum*, from the intermediate beds constituting the Lower Vicksburg, a case very similar to that before referred to under *Mactra*.

Lyria nestor n. sub-sp.

The *Lyria misssisippiensis*, of Conrad, moderately abundant in the Upper Vicksburg marl, is represented in the Red Bluff bed by this form which must be regarded as at least subspecifically distinct. It is much more elongate in outline than the Vicksburg species, and is more distinctly sculptured. The longitudinal ribbing is more obtusely rounded and less distinct. The length of a moderately large specimen is about 43 mm., with a maximum width of 18 mm. It is accurately figured by Dall (*Trans. Wag. Inst.*, III, Pl. 6) under the name *Lyria costata* Sowerby, and, in his opinion, both this and the Vicksburg form are varieties of that European species. The Vicksburg and Red Bluff forms are, however, distinctly differentiated in facies and each holds to its own type through very extended series, without exhibiting much variability.

Conrad's type of *Conomitra staminea* is apparently unique as far as the Vicksburg strata are concerned, and, from the matrix that partially envelops it, would appear to have come from the upper marl. It is a small species, about the size of the Claibornean *fusoides* and somewhat of the same form. The revolving grooves are deep and do not cross the ribs, thus forming short and very conspicuous excavated lines, nearly as in *Fusimitra cellulifera* Conrad. The species figured by Dr. Dall (*l.c.*, Pl. 4, fig. 2) is quite evidently distinct from *staminea*, and is a much larger species. It also seems to be distinct from *angulata* Heilp. The specimen figured by Dr. Dall has five body whorls and measures 15 mm. in length. A specimen of the true *staminea*, recently lent me by Mr. Aldrich and found at Byram's Ferry, having

four body whorls, measures only 8.5 mm. in extreme length. I have collected a number of specimens of *M. vicksburgensis* at Vicksburg, and feel sure that this is also distinct from *staminea*, having no suggestion of the peculiar deep coarse revolving sculpture of that species.

The *Mitra mississippiensis* of Conrad is a specimen of *conquisita* in which the revolving lyration covers the entire body whorl; it is generally effaced on the upper parts of this whorl in half-grown and older individuals, but occasionally persists until rather late in the growth of the shell. *Millingtoni* is a different species.

The *Capulus* occurring at Vicksburg is apparently different from *americanus* of the Jacksonian, at least subspecifically. It is extremely rare at Vicksburg and has been found thus far only in the upper marl.

March 3.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Seventeen persons present.

A paper entitled "Studies in American Forficulidæ," by James A. G. Rehn, was presented for publication.

March 10.

The President, Samuel G. Dixon, M.D., in the Chair.

Seventeen persons present.

March 17.

The President, Samuel G. Dixon, M.D., in the Chair.

Ten persons present.

The death of Lewis Woolman, a member, on the 13th inst., was announced.

Papers under the following titles were presented for publication:

"The Mutation of Hibiscus moscheutos L.," by John W. Harshberger.

"A Note on the Common Bottle-nose Porpoise of the North Atlantic, Tursiops truncatus (Montagu)," by Frederick W. True.

"Additions to the Japanese Land Snail Fauna, No. VIII," by Henry A. Pilsbry.

MARCH 24.

EDWIN G. CONKLIN, Ph.D., Vice-President, in the Chair.

Nineteen persons present.

A paper entitled "Life Colors of Pœcilia limantouri and Description of a new Heros from Mexico," by Henry W. Fowler, was presented for publication.

The following minute on the death of Lewis Woolman was unanimously adopted:

The Academy of Natural Sciences of Philadelphia desires to place on record its appreciation of the loss it has sustained in the death of LEWIS WOOLMAN, who, since his election to membership in 1884, has manifested a constant interest in the well-being of the society. His work in connection with the geology of New Jersey and eastern Pennsylvania, especially as illustrated by the boring of artesian wells, formed a valuable addition to knowledge. He was thorough and accurate in his methods, while his intercourse with his fellow-members was characterized by a hearty cheerfulness and sincerity. He was active in promoting the interests of the Biological as well as those of the Mineralogical and Geological Section, and during the latter months of his life he rendered service to the Academy as a member of the Committee on Accounts. His memory will be held in grateful recollection.

MARCH 31.

CHARLES SCHAEFFER, M.D., in the Chair.

Ten persons present.

The death of William V. McKean, a member, on the 29th inst., was announced.

Charles Z. Tryon was elected a member.

The following were ordered to be printed:

THE VARIATIONS OF EUTÆNIA IN THE PACIFIC SUBREGION.

BY ARTHUR ERWIN BROWN.

The portion of the Pacific coast of North America occupied by the garter snakes extends from about latitude 50° in British Columbia to the neighborhood of 33° in southern California,[1] and exhibits great variety of soil and climate, especially in the extremes of dryness and humidity. The annual rainfall at Puget Sound has reached a hundred and thirty inches, while at Yuma, in southeastern California, the average is little more than three. Under these circumstances, and having in mind the ease with which color in reptiles is acted upon by external conditions, of which there is reason to believe that moisture is one of the most active, it is not surprising that color variation should reach a maximum in a group of snakes which, through diversity of habit, occupy practically every station open to their kind. Many species and subspecies have been established from this region upon examples so few in number as to form an altogether inadequate foundation in a genus where the range of variation is as great as it is known to be in *Eutænia*—or is known, at least, to all but those naturalists who establish uniformity by the easy process of attaching a name to every difference, without regard to its nature or its biological significance.

Efforts to bring these supposed forms into some sort of order have been made in late years by Mr. G. A. Boulenger,[2] Mr. John Van Denburgh[3] and the present writer,[4] but it must be admitted that the assignment of some intermediates has been accomplished in part by the exercise of that mode of judgment which has been termed "the naturalist's instinct." Some material now in my possession bears directly upon the questions of identity involved in *E. elegans* and *E. infernalis*, and their interesting character has led me to review all the garter snakes of the region in question.

The list following contains the names of all the species and subspecies within my knowledge, with the date of establishment and the

[1] *Eutænia eques* Reuss. has been found in the peninsula of Lower California, and others may yet be taken in that little-known region.
[2] *Catalogue of Snakes in British Museum*, Vol. I, p. 192, *et seq.* (1893).
[3] *Occasional Papers California Academy of Sciences*, V, p. 199, *et seq.* (1897).
[4] *Proceedings Academy of Natural Sciences of Philadelphia*, 1901, p. 18, *et seq*

ype locality, which have been founded upon snakes belonging to the enus from this region, or whose range has been extended to enter it. hose admitted here are printed in capitals:

COLUBER PARIETALIS Say (1823). Missouri river near Council Bluffs.
Coluber infernalis Blain. (1835). California.
Tropidonotus ordinoides B. and G. (1852). Puget Sound.
Tropidonotus concinnus Hallow. (1852). Oregon.
EUTÆNIA PICKERINGI B. and G. (1853). Puget Sound.
EUTÆNIA LEPTOCEPHALA B. and G. (1853). Puget Sound.
Eutænia dorsalis B. and G. (1853). Rio Grande, Texas.
EUTÆNIA ELEGANS B. and G. (1853). El Dorado county, Cal.
EUTÆNIA VAGRANS B. and G. (1853). California.
Tropidonotus trivittatus Hallow. (1853). California.
Eutænia couchi Kenn. (1857). Pitt river, Shasta county, Cal.
Eutænia atrata Kenn. (1860). California.
Eutænia cooperi Kenn. (1860). Washington (?).
EUTÆNIA HAMMONDI Kenn. (1860). San Diego county, Cal.
E. sirtalis tetratænia Cope (1875). Pitt river and Puget Sound.
Eutænia henshawi Yarrow (1884). Walla Walla, Wash.
EUTÆNIA BISCUTATA Cope (1883). Klamath Lake, Oregon.
E. elegans plutonia Cope (1892)=type of *E. henshawi* Yarr.
E. elegans brunnea Cope (1892). Fort Bidwell, Cal.
E. elegans lineolata Cope (1892). No definite type.
E. infernalis infernalis Cope (1892). Fresno and San Francisco.
E. infernalis vidua Cope (1892)=types of *E. atrata* Kenn.
E. sirtalis trilineata Cope (1892). Port Townsend, Ore.

These names, twenty-three in number, appear to me to be reducible three species, two of which present three forms each, sufficient in numr and constant enough in character, or so associated with a restricted ea of distribution as to compel recognition as subspecies; or seven rms in all,[5] the special features of which are capable of being arranged a key which will cover all cases but the few anomalies upon which dividual judgment is required.

.—Scales in 21 rows; upper labials 8:

a.—Body moderately stout; head and eye rather small; posterior chin-shields equal or very little longer than anterior (*E. elegans*):

[5] Mr. Van Denburgh admits the same forms, but like values are not attached o them in all cases. Mr. Boulenger reduces them still further to five. As the nly purpose of this paper is to analyze the various type specimens, no attempt s made to give references beyond the original descriptions.

a'.—Usually 1 preocular:

Black with three light stripes; or brown or red with stripes and spots distinct; no nuchal blotches; head smaller, ... *E. e. elegans.*

Greenish-olive; stripes and spots not very distinct; nuchal blotches often present; ventrals often dark; head larger, ... *E. e. vagrans.*

b'.—Usually 2 preoculars; often 23 rows; color like *vagrans* or darker, ... *E. e. biscutata.*

b.—Body slender; posterior chin-shields much longer than anterior; brown, usually without stripes; spots small and irregular, ... *E. hammondi*

B.—Scales in 19 rows; upper labials 7; posterior chin-shields much longer than anterior (*E. sirtalis*):

a.—Body stout; head moderately large:

Brown or black; upper row of spots often fused into a stripe; usually red on sides, ... *E. s. parietalis.*

Usually black, with three light stripes, . . . *E. s. pickeringi.*

b.—Body small; head and eye small; often 17 rows and 6–8 labials; color variable, ... *E. s. leptocephala.*

Eutænia elegans.

Baird and Girard, Catalogue of North American Serpents, p. 34 (1853).

This species has in nearly every case 8 upper labials and 21 rows of scales, of which the outer is either smooth or very faintly keeled, but an occasional example has 19 rows, or in one form 23, and the labials are sometimes 7. Lateral stripe on the second and third rows. The head is small and delicately formed; the eye moderately small, and the posterior chin-shields are about equal to the anterior ones or very little longer. The throat and chin are almost invariably yellowish. It is to be observed that two species found together in California, *E. elegans* and *E. sirtalis parietalis*, occasionally exhibit the scale and labial formula of the other, and very rarely the former may have posterior chin-shields as long as the shortest of the latter, and a very similar color variety occurs in each; but when *elegans* has 19 rows or 7 labials it may almost always be distinguished from any form of *E. sirtalis* by its short hinder chin-shields, and from any but *E. s. leptocephala* by its small head and eye.

Three subspecies are to be admitted.

Eutænia elegans elegans.

Eutænia elegans B. and G., Cat. No. Am. Serp., p. 34 (1853).
Tropidonotus trivittatus Hallow., Proc. Acad. Nat. Sci. Phila., 1853, p. 237.
E. elegans lineolata (part) Cope, Proc. U. S. Nat. Mus., XIV, p. 655 (1892).
E. infernalis infernalis Cope, *l. c.*, p. 657 (not *Coluber infernalis* Blain.).

Baird and Girard's type of *E. elegans* was almost black in color, with

the three light stripes well defined, and had 21 rows of scales; their second specimen had 19 rows and the dorsal spots were visible against the dark ground.

Seven living garter snakes received at the Zoological Gardens of Philadelphia in May, 1902, from a collector at Oakland, Cal., throw much light upon the variations of this form.

Specimens *a*, *b*, *c*, *d*, measuring from 270 to 290 mm. in length, correspond in color to typical *elegans*, the three pale yellow stripes being on a brownish-black ground so dark that the spots are barely visible. Two have 21 dorsal rows and 8 upper labials; one has them 21 and 7; one has 19 and 8.

The three others are of mature size and much significance.

Specimen *e*, 733 mm. long (tail 175), has 19 rows of scales, the outer weakly keeled, and 8 labials. Ventrals 163; subcaudals 87. The whole dorsal color between the spots, more or less of the outer row of scales, and the entire center of the belly are bright red. The spots are distinct and number about 94 in each row, to the vent. The dorsal stripe is orange-yellow and the laterals paler, more buff, but much marked with red. The small parietal spots and those on the ends of the ventrals, common in many species, are present and the upper portion of the labial sutures are slightly margined with dark shading. The portion of the ventral surface not red is pale green. This specimen is the most brilliant and beautiful *Eutœnia* I have ever seen.

Specimen *f*, 800 mm. long (tail 184), has 19 rows of scales, the outer faintly keeled, or smooth in places; 8 upper labials which are yellowish-olive slightly bordered with black. Ventrals 168; subcaudals 72. The dorsal stripe is bright yellow, and the laterals red. Body color dark brownish-black, the upper row of spots being entirely obscured, the lower row, 84 in number, showing as downward prolongations of the black from above, and separated by not very distinct patches of red just above the lateral stripe. This portion of the color pattern closely resembles some examples of *E. s. parietalis*. The belly is yellowish-olive in the center, slightly marked with red, the pattern of this part corresponding exactly to that colored red in *e*. The ends of the ventrals and the outer row of scales are olive-brown. No parietal spots and no distinct spots on the ends of the ventrals, but their bases are slightly dusky. This snake is *E. infernalis infernalis* Cope.

Specimen *g*, 880 mm. long (tail 210), has 21 rows, the outer partly keeled and partly smooth, and 8 upper labials. Ventrals 167; subcaudals 72. In pattern it is like *e*, but the body color is mostly brown instead of red, this last showing only on a single scale here and there,

especially on the lateral stripe. There are about 90 spots in each row, the upper not very distinct. The belly is pale olive with small spots on the ends of many ventrals. No parietal spots and the labials very slightly margined. All these specimens have the small fine head, the short posterior chin-shields and the yellow throat and chin of *E. elegans*, and notwithstanding their wide difference in color, their specific unity is established by the fortunate fact that specimen *g* was a female, gravid at the time of death, and I removed from her thirteen young, twelve of which are typical *elegans* in color, being so dark that the spots are barely visible, and corresponding exactly to specimens *a*, *b*, *c*, *d*. The thirteenth is also dark, but when first taken from the mother showed red markings on the flanks like those of specimen *f*. This red has almost entirely disappeared after twelve weeks in spirits. All of these young snakes have 21 rows of scales; ten have 8 labials; three have 7 on one side. The temporals range from 1–2–3 to 2–3–1. We have, then, unborn young exhibiting the colors of *elegans* B. and G. and *infernalis infernalis* Cope, the one resembling the latter having the scales and labials of *elegans*, contained in the oviducts of a female which, differing from both in color, departs in no other way from the features of *elegans*. If the red, which is a purely individual acquisition, were omitted, specimen *g* would come very close to *E. e. lineolata* Cope, some of which are referable to the present subspecies and some to *E. e. vagrans*.

Tropidonotus trivittatus Hallow. is no more than a typical *elegans* with 19 rows.

E. e. elegans appears to occur only in California, from Shastha in the north down to the San Bernardino mountains, beyond which it seems not to extend.

Eutænia elegans vagrans.

Eutænia vagrans B. and G., Cat. No. Am. Serp., p. 35 (1853).[6]
Eutænia couchi Kenn., U. S. Pac. R. R. Surv., X, Pt. 4, p. 10 (1857).
Eutænia henshawi Yarrow, Proc. U. S. Nat. Mus., VI, p. 152 (1884).
E. elegans plutonia Cope, Proc. U. S. Nat. Mus., XIV, p. 653 (1892), and Rep. U. S. Nat. Mus., 1898, p. 1035.
E. elegans brunnea Cope, Proc. U. S. Nat. Mus., XIV, p. 654 (1892).
E. elegans lineolata (part) Cope, *l. c.*, p. 655.

This form ranges over the higher portion of the great plains, from whence it has penetrated through the valleys of the Snake and the Columbia rivers to the western coast. It is the garter snake of the Sierras and the Rocky mountains. I have taken it at 6,000 feet eleva-

[6] *Eutænia kennicotti* Jan (*Arch. Zool. Anat. and Phys.*, III, 1865, p. 216), with 21 rows and 8 labials, may belong here, but the description is vague, and the only locality given is northern United States.

on in Montana, and two of the Academy's specimens were collected y Dr. Henry Skinner at Sapello, New Mexico, at an altitude of 10,000 et.

The scutellation is similar to *E. e. elegans*, but the body is on an verage larger and of stouter build. The head is larger and the eye elatively small.

The color is almost always greenish or light olive, with the pale yelow stripes narrow, not distinct, and often encroached upon by the mall and ill-defined spots. An occasional example is brown, but *agrans*, notwithstanding its extensive range, varies less than *elegans*. Jsually there is a pair of dark nuchal blotches and the ventrals are nore or less clouded with dark slate. While ordinary specimens are ufficiently distinct from *elegans*, there are intermediates in the western ortion of its range, such as those called *E. e. lineolata* Cope, which educe *elegans* and *vagrans* to the rank of subspecies.

No examples of *E. e. brunnea* Cope are known but the two types ollected at Fort Bidwell, Cal. These anomalies might almost as vell be regarded as *E. e. elegans*, but their robust build and the locality vhence they came incline me to refer them to the present form.

The type of *E. couchi* Kenn. came from Pitt river, Cal., three hunlred miles north of the known limit of *E. hammondi*, with which it has ommonly been associated, and I agree with Van Denburgh in regardng the specimen as an anomalous *vagrans*.

There does not seem to be any reason to consider Cope's type of *E. e. plutonia*, from Walla Walla, Washington, as anything more than a nelanistic *vagrans*. It is to be observed that Yarrow had already given the name of *E. henshawi* to this specimen, at the same time lescribing Cope's second example, from western Arizona, as *E. vagrans plutonia*.

Eutænia elegans biscutata.

Eutænia biscutata Cope, Proc. Acad. Nat. Sci. Phila., 1883, p. 21.

In western Oregon and Washington, and especially in the humid northwestern portion of the last state, *E. e. vagrans* is largely replaced by snakes generally similar but with a decided tendency toward melansm, and having usually two or three preoculars and sometimes 23 rows of scales. The types of *E. biscutata* were almost black and came from Klamath Lake, Ore., the most easterly locality from which t has been known, and where the rainfall is heavy. The association of these tendencies with a restricted area of distribution seems to require that it shall be recognized as a subspecies of *E. elegans*.

Eutænia sirtalis.

Coluber sirtalis L., Syst. Nat., Ed. X, p. 222 (1758).

The usual scutellation in this species is 19 rows and 7 upper labials, a formula which is very constant in the east, but in western forms 17 to 21 rows, or 6 to 8 labials sometimes occur. The lateral stripe is on the second and third rows. Compared with *E. elegans* it is larger and stouter, with a moderately large head. The posterior chin-shields are much longer than the anterior. East of the Mississippi river red is rarely developed, but I have seen one *E. s. sirtalis* from North Carolina which showed much of that color upon the sides, and another from Pennsylvania, in my own collection, is marked slightly with it on the flanks, but from the great plains westward there is a general disposition in reptiles to develop red, and it is more or less present in most subspecies of *E. sirtalis* from those parts.

Eutænia sirtalis parietalis.

Coluber parietalis Say, Long's Exp. to Rocky Mts., I, p. 186 (1823).
Coluber infernalis Blainville, Nouv. Ann. Hist. Nat., IV, 1835, p. 291, Pl. XXVI, fig. 3.
Tropidonotus concinnus Hallow., Proc. Acad. Nat. Sci. Phila., 1852, p. 182.
Eutænia dorsalis B. and G., Cat. No. Am. Serp., p. 31 (1853).
Eutænia ordinoides B. and G., *l. c.*, p. 33.
E. sirtalis tetratænia Cope (*Fide* Yarrow); U. S. Geol. Surv. W. of 100th Mer., V, p. 546 (1875), and Proc. U. S. Nat. Mus., XIV, p. 664.
E. sirtalis trilineata (part) Cope, Proc. U. S. Nat. Mus., XIV, p. 665 (1892).

E. s. parietalis has a range quite as wide as *E. e. vagrans*, for while it is absent from Arizona, and appears to be rare in Utah, it extends farther to the east on the plains. The scutellation is 19 rows and 7 labials, but now and then it has 8 labials, and more rarely 21 rows. It is ordinarily dark brown, with the spots more or less obscured and the lower row separated by red which shows on the skin and usually on the scales in life, though much of it quickly fades in spirits. The small dark spots on the ends of the ventrals and the dark margins to the labials are either present or absent. The belly is yellow, various shades of slate, or almost black in dark specimens. The outer row of scales is often smooth, but sometimes weakly keeled.

There is much difference in the amount and distribution of the red, especially in those from the Pacific coast, and there is a tendency toward melanism, strongly marked in the moist region of Oregon and Washington. In conformity with the law of color development in snakes this excess of pigment shows first upon the dorsal surface adjacent to the vertebral stripe, sometimes obscuring part or the whole of the upper row of spots (*E. dorsalis*); when it extends down far enough to reach the upper border of the lower row, these are left as

·d prolongations of the upper dark area, with red markings (*E. parietalis*); when it extends to the lateral stripe all the ɜ obliterated (*E. pickeringi*). A very few individuals show om part of the lower row also obscured, leaving a series of s above (*E. concinna*); or the red has spread longitudinally, a red stripe between two black ones (*E. s. tetratænia*).

: above, the few specimens of *E. dorsalis* came from the Rio valley, in New Mexico and Texas, except one fugitive noted from Portland, Ore., thirteen hundred miles away. Of the ·atænia which Cope is able to name, two, in the U. S. National , came from Pitt river, Cal., while the third, No. 6,085 in the y's collection, from Puget Sound, originally entered as *con-* as the lower black stripe broken up into spots anteriorly. A ınake in the same jar as this specimen, and apparently collected is an ordinary *parietalis*. Hallowell's type of *Tropidonotus* ꞉s (No. 6,324, Academy collection) is also marked on the *tratænia*" by Cope. All these specimens have now been fifty ɜpirits. The three *concinna* cited by Cope all came from western

the exception of *E. s. pickeringi*, these selections of special a physiological process appear to me quite arbitrary, and if ɜctness of the method is once admitted, an indefinite number ɜ may as well be allowed.

and Girard's type of *Tropidonotus ordinoides*[7] came from ound, and the original description cannot be reconciled with en of California specimens under the same name by these in their *Catalogue* of the following year. The type was prob- *E. s. leptocephala*. Those subsequently described had 19–21 scales, and the chief difference from ordinary *parietalis* was lateral spots were reddish-brown instead of red. A California is figured by Baird[8] with the form of head and the long posterior ꞉lds of *parietalis*, and 8 labials, but as the last-named species es exhibits this number, it seems safe to refer *ordinoides* here, ıan to regard it with Cope as a subspecies of *E. elegans*.

ɜrnalis infernalis Cope has been shown to be *E. e. elegans*, but *nfernalis* Blain. occupies a somewhat doubtful position through ficiency of the original description and plate. Bocourt[9] adds ıas 19 rows and 7 labials, which is the common formula for

Acad. Nat. Sci. Phila., 1852, p. 176.
ʔ. *R. Report*, Pl. XXVI, fig. 3.
Soc. Zool. de France, 1892, p. 40.

parietalis, while his figures of Blainville's specimen[10] suggest this species rather than *elegans*; and as California examples of both these forms sometimes exhibit the *infernalis* style of coloring, I see no reason at present to regard Blainville's type as anything more than the present species.

Eutænia sirtalis pickeringi.

Eutænia pickeringi B. and G., Cat. No. Am. Serp., p. 27 (1853).
E. sirtalis trilineata (part) Cope, Proc. U. S. Nat. Mus., XIV, p. 665 (1892).

In the extreme west of Oregon and Washington, and especially about Puget Sound, a region of much moisture, melanism reaches an extreme and fairly constant degree in *E. s. pickeringi* B. and G. and *E. s. trilineata* Cope, the differences between which are trivial.[11]

E. s. pickeringi seems to be entitled to rank as a well-marked geographical form, always so dark as to obscure the spots, stripes usually narrow, very distinct and variable in color, occasionally a little red on the sides, and the ventral surface always more or less dark, sometimes entirely black.

Eutænia sirtalis leptocephala.

(?) *Tropidonotus ordinoides* B. and G., Proc. Acad. Nat. Sci. Phila., 1852, p. 176.
Eutænia leptocephala B. and G., Cat. No. Am. Serp., p. 29 (1853).
Eutænia atrata and *E. cooperi* Kenn., Pac. R. R. Surv., XII, Pt. 2, p. 296 (1860).
E. infernalis vidua Cope, Proc. U. S. Nat. Mus., XIV, p. 658 (1892).

This variable form is somewhat small in size and relatively stout; the head and eye are notably smaller than in other subspecies of *E. sirtalis*, and even more so than in *E. e. elegans*.

The rows of scales are 17 or 19, the outer either smooth or keeled; upper labials usually 7, but sometimes 6 or 8; preoculars occasionally 2 and in a few cases 3. Posterior chin-shields much longer than the anterior. The color is olive, greenish or blackish-brown, the three light stripes variable in color and sometimes absent; spots small and hardly to be seen in dark specimens; labials sometimes narrowly margined; parietal spots present; ventrals 139–152, yellow, greenish or dark slate. Some individuals with 19 rows and 7 labials so nearly resemble certain phases of *E. s. parietalis* or *E. s. pickeringi*, and in fact some eastern *E. s. sirtalis*, that I cannot regard it as more than a subspecies, occupying British Columbia, western Washington and Oregon and northern California.

E. cooperi Kenn. is clearly referable to this form. It has already been pointed out that the type of *Tropidonotus ordinoides* B. and G.

[10] *Miss. Sci. au Mexique*, etc., Pl. 55, figs. 2, 2*a*, 2*b*.

[11] Cope's examples of *trilineata* from Fort Benton, Montana, are probably *E. s. parietalis*.

(1852) was perhaps a *leptocephala*, but the fact cannot now be verified, and a mere possibility should not be allowed to disturb existing nomenclature.

E. infernalis vidua Cope was founded upon Kennicott's original specimens of *E. atrata*. One of these is now No. 6,359 (original number 970) in the collection of the Academy of Natural Sciences, and there is a second, No. 6,584, marked *vidua* in Cope's handwriting. Both of these specimens are labeled "San Francisco." I have elsewhere stated[12] that Cope's description is not accurate in details and have given my reasons for assigning these specimens to *leptocephala*. Mr. Van Denburgh considers them to be *E. e. elegans*, and states that this color form has been found only on the coast slope of the peninsula of San Francisco, and questions the occurrence of *leptocephala* in California. In consequence, I have reëxamined the two examples of *vidua* and am still inclined to refer them to *leptocephala*, leaving the geographical part of the problem for further investigation.[13]

In any event *vidua* would be no more than a synonym of *atrata*.

Eutænia hammondi.

Eutænia hammondi Kenn., Proc. Acad. Nat. Sci. Phila., 1860, p. 332.

Hammond's garter snake does not range north of Fresno county, Cal., but extends southeastward into the plains of Arizona.

The scutellation is that of *E. elegans*, but the body is slender, the head is narrow and elongated and the posterior chin-shields are much longer. The color is grayish or olive-brown; dorsal stripe narrow, indistinct or absent; the spots are always indistinct and sometimes absent, though indicated by black dots on many scales. Ventral surface yellowish, often with dark bases to the scuta, and at times clouded with slate toward the tail; this usually forms a line along the sutures between the subcaudals. Parietal spots and nuchal blotches present; labials dark bordered, and a more or less evident pale post-oral crescent.

This form has been regarded by some authors, including myself, as a subspecies of *E. elegans*, but further study of fresh material has satisfied me that it is distinct enough in character and geographical range to be admitted to specific rank.

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[12] *Proc. Acad. Nat. Sci. Phila.*, 1901, p. 30.

[13] There may be a doubt as to the exact localities where the specimens on which *vidua* was founded were collected. Kennicott gave none in the original description of *E. atrata*, but in a footnote Dr. Cooper, the naturalist of the survey, says "California." The one in the Academy's collection is labeled "San Francisco," but there is also in the collection an undoubted *leptocephala* of about the same date, bearing a like label. San Francisco has always been the point at which all California interests center.

The only other name with which it has been confused is *E. couchi* Kenn., which has been shown to be in all probability an aberrant *E. e. vagrans*.

The geographical relations of the species here discussed are as follows: *E. e. elegans* meets with *E. e. vagrans* and *E. s. parietalis* throughout its range. At its southern extension it is overlapped by *E. hammondi* and at its northern it touches *E. s. leptocephala*. *E. e. vagrans* meets *E. hammondi* in California, and is in contact with *E. s. parietalis* almost everywhere except in Arizona, although the latter does not appear to ascend as high in the mountains. In the northwest it merges into *E. e. biscutata* and reaches *E. s. leptocephala*. On the plains it meets *E. radix*, and in the southwest comes more or less in touch with *E. marciana*, *E. eques* and perhaps *E. megalops*.

E. s. parietalis meets all of these except the last. In the east it overlaps scattering examples of *E. s. sirtalis* and probably *E. proxima*. In the far northwest it merges into *E. s. leptocephala* and *E. s. pickeringi*.

E. hammondi meets with *E. marciana* in the eastern part of its range in Arizona.

The connection between moisture and variability, especially in the direction of color intensity, may be profitably observed in these snakes.

More than a million square miles of the territory occupied by the widely ranging *E. e. vagrans* and *E. s. parietalis* lies east of the high mountain chains of the Pacific coast and has an annual rainfall of from 10 to 25 inches. Over this vast expanse the characters of these two species are very constant, and variation has contributed to the list of synonyms only *E. dorsalis* B. and G., in which melanism is in its earliest stage, and the one specimen of *E. henshawi* Yarr. (=*E. e. plutonia* Cope) from Walla Walla.

The region of great moisture, with a rainfall of from 50 to over 100 inches, occupies not more than a hundred thousand square miles, extending from latitude 40° in northern California to British Columbia. The type localities of the following five forms, characterized by pronounced melanism and often an excess of red, all fall within this restricted area: *E. ordinoides*, *E. concinna*, *E. pickeringi*, *E. s. tetratænia* and *E. s. trilineata*. In addition to these, *E. e. biscutata* and *E. s. leptocephala*, found there, also show marked tendencies to develop dark colors as well as instability in scutellation.

Five forms—*E. infernalis* Blain., *E. i. infernalis* Cope, *E. i. vidua*, *E. atrata* and *E. e. elegans*—were described from the neighborhood of San Francisco, where the actual rainfall does not exceed 25 inches,

but where much moisture is carried over the coast belt and up the river valleys by the persistent fogs which sweep in from the Pacific ocean.

The region occupied by *E. hammondi* is exceedingly dry, with a rainfall of less than 10 inches, and this species is relatively constant and is not known to show any tendency to melanism.[14]

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[14] That humidity in some way influences the metabolic processes which lead to pigmentation can hardly be doubted. Temperature need scarcely be considered in the present case, for the dry region, extending from Arizona to northern Montana, and to considerable elevations, has a very great thermal range, while the wet region is relatively equable. There is a suggested connection between the large amount of uric acid produced by reptiles and the fact that the yellow and orange coloring matter from the wings of certain butterflies has yielded a substance closely related to uric acid, but physiological chemistry is not yet competent to explain how these waste products are converted into pigments.

The liberty to indulge in the striking colors developed in the garter snakes of this region is partly due to the protection afforded by luxuriant vegetation, and perhaps in some degree to the absence of the three snake-eating genera *Spilotes*, *Ophibolus* and *Elaps*.

A NEW SPECIES OF NYCTALEMON.

BY HENRY SKINNER.

Nyctalemon curvata ♂ n. sp. Plate XIII.

Upper side. Primaries dark smoky-brown, almost black. The costa is crossed by a number of very narrow, pale slate-colored lines which break up the ground color into spots. A distinct white band or fascia crosses the wing from the costa to the interior margin; this band commences on the costa 30 mm. from the base of the wing, measured along the costa; it ends on the interior margin 34 mm. from the base of the wing. The band is 3 mm. wide at the costa and gradually grows narrower. Its white color ends before it reaches the exterior margin. The band is distinctly divided into seven white spots by the dark nervures and it is markedly curved, the concave side being inward. There are no other markings except that the apices are slightly lighter in color. Secondaries. The wings are the same color as the primaries and are crossed by a band or fascia some shades lighter than the ground color of the wing; from this toward the base are no markings. Beyond the band toward the outer margin the wings are lighter in color and are marked with a long black shade and a number of somewhat linear black markings. The exterior margin is broken into two small and one long point and there is also a long broad tail to the wing. Commencing in the larger point is a black band about 2 mm. wide and forming the edge of the wing and extending to the interior margin. It crosses the larger tail about 10 mm. from the tip, leaving the latter white from where it crosses to the end.

Under side. Primaries. The ground color of the wings is much lighter; the white band is the same as above, except that it extends unbrokenly white to the exterior margin. There is a black shade beyond the band on the apex side and numerous black, somewhat linear markings; the tip of the wing is whitish. There is also a black shade on the inner side of the band and the linear markings are also found toward the base of the wing. The secondaries are marked in the same general way and the band is distinctly white but narrower than on the primaries. It terminates in an irregular black band-like spot which reaches the interior margin. Expanse (from body to apex of wing on one side) 62 mm. The very dark color, the comparatively wide and very distinct, curved white band serve to distinguish this species from the others in the genus. Described from two specimens presented to the Academy of Natural Sciences of Philadelphia by Prof. Levi W. Mengel. They are from Tonga, off Santo, New Hebrides, Oceanica.

STUDIES IN AMERICAN FORFICULIDÆ.

BY JAMES A. G. REHN.

The material treated in the following pages is contained in the collection of the United States National Museum. The privilege of examining this series was secured through the kindness of Mr. William H. Ashmead, Assistant Curator of Insects in that institution.

Family FORFICULIDÆ.

The general arrangement of the species under this family is according to the system used by De Bormans and Krauss.[1] The scheme of classification recently proposed by Verhoeff[2] has not been considered, as the writer has made no investigations into the characters there brought into prominence.

Genus PYRAGRA Serville.

1831. *Pyragra* Serville, Ann. Sci. Nat., XXII, p. 34.

Type: *P. fuscata* Serville.

Pyragra fuscata Serville.

1831. *Pyragra fuscata* Serville, Ann. Sci. Nat., XXII, p. 34. [Cayenne.]

One female; San Carlos, Costa Rica. (Schild and Burgdorf.) [U. S. N. M.]

The use of Dohrn's later name *saussurei* for this species appears unwarranted, as Serville's specific name is based on a description which is fairly complete, and perfectly applicable to this form.

This species has been recorded from localities between south central Mexico (Cordova and Atoyac) and French Guiana.

Genus ECHINOPSALIS De Bormans.

1893. *Echinopsalis* De Bormans, Biol. Cent.-Amer., Orth., I, p. 2.

Type: *E. guttata* De Bormans.

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[1] *Das Tierreich*, 11 Lieferung: Forficulidæ und Hemimeridæ, Berlin, 1900.
[2] *Zoologischer Anzeiger*, XXV, pp. 181–208; and *Sitzungs-Bericht der Gesellschaft naturforschender Freunde*, Berlin, 1902, pp. 7–18.

Echinopsalis brevibractea n. sp.

Type: ♂ (immature); Motzorongo, Vera Cruz, Mexico. January, 1892. (H. Osborn.) [U. S. N. M.]

This form apparently belongs to the genus *Echinopsalis*, though not wholly agreeing with the generic diagnosis. Difference from the generic characters is noticed in the longer third antennal joint, the subtruncate posterior margin of the pronotum, the shorter anal segment and in the longer, more attenuate forceps. No close relationship exists with the only previously known species, *E. guttata* De Bormans from Chontales, Nicaragua.

Body of moderate length, considerably depressed; surface subscabrous, covered with short, stiff, mostly erect hairs. Head rather flat, slightly narrower than posterior width of the pronotum, the posterior margin subemarginate centrally; basal joint of the antennæ inverted conoid, shorter than the uniform cylindrical third joint, fourth and succeeding joints (beyond eleventh missing) short and thick, bead-like, broader than long. Pronotum subquadrate; anterior margin broadly rounded, the angles not at all apparent; posterior margin subtruncate; median sulcus well marked and extending the entire length of the pronotum; lateral margins considerably raised. Tegmina and wings only partially developed, but in such condition the former almost equal the pronotum in length. Anal segment moderately deep, over twice as wide as long, very heavily hirsute. Subgenital plate broad, the apex gently rounded. Forceps trigonal in section; rather elongate, parallel and unseparated; the inner margins finely toothed, this being stronger and more apparent basally; apical portion moderately incurved, crossed. Femora rather robust, uncurved; tibiæ moderately slender, not equalling the femora in length. Tarsi moderately compressed, the first and third joints about equal in length.

General color wood-brown, the limbs being mottled with touches of dirty-yellowish.

Measurements.

Total length (approximately),	9.5 mm.
Length of pronotum,	2.5 "
Width of pronotum,	2.5 "
Length of anal segment,	1.5 "
Length of forceps,	3.5 "

Four specimens, all from the type locality, have been examined. In one of these eighteen joints are present in the antennæ, twenty-two being credited to *E. guttata;* this possibly being true of *brevibractea* in the unbroken antennæ.

Genus **LABIDURA** Leach.

"1815. *Labidura* Leach, Edinburgh Encyc., IX, p. 118."

dura bidens (Olivier).

1791. *Forficula bidens* Olivier, Encyc. Méth., Hist. Nat., VI, Pt. II, p. 466. [Jamaica.]

'welve specimens; six males, two females, four specimens damaged sex uncertain.

ermuda. [U. S. N. M.] (damaged).

'abanas, Cuba. June 2. (Palmer and Riley.) [U. S. N. M.]

uanajay, Cuba. April 30. (Palmer and Riley.) [U. S. N. M.]

'his name has recently[3] been revived for the form occurring in the st Indies, Mexico and Colombia. De Bormans and Krauss place s a synonym of *pallipes* Fabricius, but as Kirby says, the latter ie "is usually applied to the dark form of *L. riparia;* the types are , and the insect cannot be identified till more specimens are received n its locality, the Cape Verde Islands."

'he specimens from Bermuda are badly damaged, and are placed ler this name with some uncertainty.

Genus **PSALIS** Serville.

1831. *Psalis* Serville, Ann. Sci. Nat., XXII, p. 34. Included *P. americana* (Palisot) and *P. morbida* Serville.

is americana (Palisot).

1817. *Forficula americana* Palisot, Ins. Rec. en Afr. et Amér., p. 165, Orth., t. 14, fig. 1. [San Domingo.]

'en specimens; nine males, one female; San Carlos, Costa Rica. iild and Burgdorf.) [U. S. N. M.]

'his large and striking species has been recorded from localities nding from Chontales, Nicaragua, to western Colombia and Vene- a, and also from Cuba and Haiti.

i the mature specimens (6) in this series a slight variation is noticed he internal margins of the forceps. In four specimens these are itly extended basally and distinctly crenulate. In two these s are straight and with the crenulations hardly visible. The im- ure specimens (all males) are very interesting and might easily nistaken for members of the genus *Anisolabis*. Two stages, rather erent in general appearance, are represented in the series and are thy of separate description.

ne conclusion reached from a study of these specimens is, that the iature forms possess lateral folds on the abdominal segments which ctically disappear by the time the adult stage is reached.

Ann. and Mag. Nat. Hist., 7th ser., XI, p. 66, January, 1903.

Size medium (25 mm.); body fusiform; surface rather polished, the abdomen and forceps finely punctate, the whole sparsely beset with stiff bristles, and the abdominal segments fringed with fine hairs. Head considerably broader than the pronotum. Pronotum slightly longer than broad; the anterior margin subtruncate, the posterior rotundate; the median region bearing a shallow sulcation, deepest anteriorly. Meso- and metanotum with the tegmina and wings incompletely developed. Abdomen rather broad, the four anterior segments with the lateral folds but slightly developed. Anal segments large, subquadrate, the posterior constriction being slight; median sulcus slightly developed posteriorly. Forceps of medium length, robust, triangular in section, the right more curved and less hooked than the left, and crossing the latter; internal margins minutely undulate, exhibiting no signs of true teeth. Femora short and robust, the greatest thickness being toward the base. Tibiæ slightly shorter than the femora in the median pair of limbs, equal in the others.

General color blackish-brown; clypeus, labrum, mandibles, tibiæ and tarsal joints dirty yellow (gamboge); femora of the general color with an apical ring of dirty yellow. Antennæ dull-brown with the first, second, thirteenth and fourteenth joints yellow.

Measurements.

	Largest Specimen.	Average of three specimens.
Total length,	25.0 mm.	22.7 mm.
Length of pronotum,	3.2 "	2.8 "
Width of pronotum,	3.0 "	2.6 "
Length of forceps,	4.5 "	3.7 "
Length of anal segment,	3.1 "	2.7 "
Anterior width of anal segment,	5.1 "	4.2 "

The other stage, which represents a lower and more undeveloped type than that described above, is represented in the series by a single specimen.

Size rather small (13.5 mm.); body subfusiform, the greatest width being abdominal; surface moderately polished and with stiff bristles generally distributed, the apical dorsal segments of the abdomen being margined with fine hairs, which are also present on all the ventrals. Head rather elongate, broader than the pronotum. Pronotum about as broad as long, the anterior margin subtruncate, the posterior rotundate; median sulcus distinctly marked. Mesonotum posteriorly truncate; metanotum centrally emarginate. Abdomen broad, each dorsal segment (except the apical three) with the posterior margin

bearing a series of folds or plaits, which are generally disposed in rows of four on each side, these being most numerous anteriorly and vanishing posteriorly. Ventral surface of the abdomen with the segments apically with small nodes, somewhat like the folds of the dorsal surface, but these being very irregularly distributed. Such folds and nodes are, in many cases, set with stiff bristles. Anal segment not very long, rather broad, the surface almost flat; median sulcus very broad and shallow. Forceps of medium length, rather robust, triangular in section, the left exceeding the right in length; internal margins not toothed, almost straight. Femora short and robust; tibiæ rather compressed, heavy, shorter than the femora in the posterior and median pairs, equal in the anterior pair.

General color blackish-brown; labrum, portions of clypeus and mandibles, tibiæ and tarsal joints dirty yellow (gamboge); femora of the general color becoming suffused with yellowish apically; antennæ wood-brown, the apical portion of basal joint washed with dull-yellowish.

Measurements.

Total length, ...	13.5 mm.
Length of pronotum, ...	2.0 "
Width of pronotum, ...	2.0 "
Length of forceps, ...	3.0 "
Length of anal segment, ...	1.5 "
Anterior width of anal segment, ...	2.7 "

Psalis pulchra n. sp.

Type: ♂; San Carlos, Costa Rica. (Schild and Burgdorf.) [U. S. N. M.]

This species is apparently closest allied to *P. americana* and *gagathina*, both of which very considerably surpass it in size, and from which it differs in the more elongate pronotum, the comparatively heavier forceps and different coloration. Relationship appears to exist with *P. rosenbergi* Burr from Ecuador, but *pulchra* may readily be separated by color as well as the non-pilose body.

Body of medium size (for the genus); elongate fusiform; surface moderately polished. Head broader than the pronotum; antennæ 15 to 16-jointed, third joint shorter than the basal, fourth and fifth rather small and rounded, sixth to eighth elongate, increasing in size, ninth to extremity equal to the eighth in size and shape—the apical portion of each segment being enlarged and of considerable greater size than the base. Pronotum longer than broad and slightly constricted posteriorly; anterior margin subtruncate, the posterior roundly produced centrally, lateral margins considerably deflected upward;

median sulcus distinctly marked except at the extreme posterior margin, which is strongly depressed and flattened, a condition also found in the lateral margins. Tegmina of considerable length, reaching to the base of the posterior femora; the anterior shoulders broadly rounded; extremities subtruncate. Exposed portions of the wings about half as long as the tegmina, the posterior and external margins broadly rounded. Abdomen with the lateral margins almost parallel, the basal segments bearing on their margins minute nodes, each of which gives rise to one or more bristles. Anal segment deep, subrectangulate in outline; median line hardly visible; the apical section bearing, between the bases of the branches of the forceps, a transverse depression. Subgenital plate triangular in outline; apex broadly emarginate, and provided with long, soft hairs. Forceps short and heavy, not quite equal to half the exposed abdomen in length, triangular in section basally; apical portion strongly incurved; the right arm longer than, and overlapping, the left, internal right edge finely crenulate, a minute tooth being developed just before the base. Femora moderately heavy, compressed; tibiæ about equal to the femora in length; third tarsal joint shorter than first, the first and second joints heavily haired below, second joint very small.

General color deep mahogany-brown, becoming dirty yellow on the limbs and lower surface of the head and thorax. Pronotum margined laterally with very dull-yellowish. Head reddish-brown. Antennæ with the two basal joints reddish-brown; the tenth, eleventh and part of the twelfth pale-yellowish; remainder of the general tint. Tegmina bearing shoulder spots of straw-yellow. Exposed wings with the basal half straw-yellow.

Measurements.

Total length,	19.5 mm.
Length of pronotum,	2.5 "
Width of pronotum,	2.0 "
Length of tegmina,	4.5 "
Anterior width of anal segment,	3.5 "
Length of anal segment,	2.2 "
Length of forceps,	3.0 "

Genus ANISOLABIS Fieber.

1853. *Anisolabis* Fieber, Lotos, III, p. 257. Included *A. maritima* and *mœsta*.

Anisolabis annulipes (H. Lucas).

1847. *Forficesila annulipes* H. Lucas, Ann. Soc. Ent. France, 2e ser., V, Bull., p. lxxxiv. [Jardin des Plantes, Paris; supposed to have been transported from North America.]

One male; Minatitlan, Vera Cruz, Mexico. February 1, 1892. (H. Osborn.) [U. S. N. M.]

Anisolabis antoni (Dohrn).

1864. *Forcinella Antoni* Dohrn, Entom. Zeitung, Stettin, XXV, p. 289. [Venezuela.]

Two females:

Mexico. (Dugés.) [U. S. N. M.]

Minatitlan. Vera Cruz, Mexico. February 1, 1892. (H. Osborn.) [U. S. N. M.]

These specimens measure 15 and 12.5 millimeters in total length.

This species has been recorded from San Luis Potosi, Mexico; Capetillo, Guatemala; Chontales, Nicaragua and Venezuela.

Genus **LABIA** Leach.

"1815. *Labia* Leach, Edinburgh Encyc., IX, p. 118."

Labia guttata Scudder.

1876. *Labia guttata* Scudder. Proc. Boston Soc. Nat. Hist., XVIII. p. 265. [Texas.]

One female; Orizaba, Vera Cruz. Mexico. January 9–16, 1892. (H. Osborn.) [U. S. N. M.]

This specimen does not wholly agree with Scudder's description, but still seems referable to this species.

Labia flaviscuta n. sp.

Type: ♀; Orizaba, Vera Cruz, Mexico. January 9–16, 1892. (H. Osborn.) [U. S. N. M.]

Apparently allied to *L. arcuata* Scudder, but differing in the elongate pygidium, the shorter exposed portion of the wings, and the predominance of yellow instead of black on the pronotum. From *L. championi* De Bormans, the only other form to which it appears at all allied, it can be immediately separated by the thirteen-jointed antennæ, the shorter exposed portion of the wings, and the narrower pygidium.

Body of very small size (5.5 mm.); greatest width at the apical portion of the abdomen; surface of the head and pronotum moderately polished, abdomen and tegmina dull. Antennæ thirteen-jointed, the fourth and fifth joints much shorter and more bead-like than the apical segments. Pronotum slightly longer than broad; anterior margin very broadly rounded; posterior margin gently rounded; laterals parallel; median sulcus reduced to a slight groove on the posterior half. Tegmina short, not more than one and a half times as long as the pronotum, but slightly extended laterally, the shoulder angles well rounded; apex subtruncate. Exposed portion of the wing very small, apparent only as the extreme tip, and placed next the median suture. Abdomen with well-developed side folds present on two of the median segments. Anal segment and subgenital plate small, transverse, the apical margins

truncate. Pygidium slightly longer than basal breadth, diminishing in width, apex truncate. Forceps simple, unarmed, about equal to half the length of the abdomen; basal halves of the arms subparallel, apical halves bent at an angle and meeting, together forming an acute angle.

General color brownish-black above, reddish-brown below. Pronotum with the anterior two-thirds reddish-orange, posterior third brownish-black. Antennæ wood-brown, with the two apical joints pale-yellowish. Limbs brownish-orange.

Measurements.

Total length	5.5 mm.
Length of pronotum	1.0 "
Width of pronotum	1.0 "
Length of tegmina	1.2 "
Length of forceps	1.0 "

Labia rotundata Scudder.

1876. *Labia rotundata* Scudder, Proc. Boston Soc. Nat. Hist., XVIII, p. 263. [Mexico.]

One female: Orizaba, Vera Cruz, Mexico. January 9–16, 1892. (H. Osborn.) [U. S. N. M.]

This specimen exhibits one structural difference from the original description, in that the posterior angles of the pronotum are rather narrowly rounded, instead of "very broadly rounded."

This species has been recorded from Mexico, Guatemala City, Aceytuno and Dueñas, Guatemala.

Genus **SPARATTA** Serville.

1839. *Sparatta* Serville, Orthoptéres, p. 51.

Type: *S. pelvimetra* Serville.

Sparatta flavipennula n. sp.

Types: ♂ and ♀ : Motzorongo, Vera Cruz, Mexico. January, 1892. (H. Osborn.) [U. S. N. M.]

Apparently allied to *S. pelvimetra* Serville, but differing in the broader and shorter pygidium, the shorter anal segment, the unarmed and sublamellate inner edge of the forceps, and different general coloration. Relationship also appears to exist with *S. pygidiata* and *semirufa* Kirby, but from the former it can be separated by the deeper anal segment, the longer pygidium and strongly toothed forceps; and from *semirufa* by the same characters and the longer points to the forceps.

♂ (not quite mature). Size small; body strongly depressed, broadest in the abdominal region, sparsely clothed with rather long bristles. Head equal to the pronotum in width; antennæ with the first and third

terior margin subtruncate; greatest width of the pro-
the anterior angles; median sulcus very slight. Anal
sverse, the depth not exceeding one-third the width;
gin truncate; median section with a longitudinal sulca-
um triangular, subconoid, the apex truncate. Forceps
o the abdomen in length, parallel; apical regions incurved,
not lapping; inner margins with a very slight lamellate
asal two-thirds, this edge being crenulate and not dentate.
late transverse, slightly emarginate centrally. Femora
heavily developed. Tibia shorter than the femora,

lor of the upper surface blackish-brown, slightly polished;
æ, forceps and limbs pale reddish-brown, deepest in the
imbs. Under surface reddish-brown; the subgenital plate
same pale tint as the forceps.
nedium; body strongly depressed. Head about equal to
n in width; antennæ imperfect. Pronotum longer than
ior portion produced centrally, the antero-lateral angles
ded; posterior margin and postero-lateral angles broadly
atest width of pronotum between postero-lateral angles;
s slight, obsolete posteriorly. Tegmina half as long again
um; lateral margins parallel, the shoulders rounded; apical
n as a unit, rounded. Exposed portions of wings about
as the tegmina, rounded. Anal segment transverse,
gain at anterior margin as deep, contracted, apical portion
narrower than basal. Pygidium half as long again as
tapering, apex truncate. Forceps considerably less than
in length, parallel, apical portion moderately hooked; in-
s being a slight lamellate edge, this edge being present on
ical fourth, though subobsolete basally; basal internal sec-
a very distinct tooth. Subgenital plate deep, about half
in as long; apical margin very broadly rounded.
lor of the upper surface blackish-brown, slightly polished;
bs, anal segment and forceps reddish-brown, deepest in
anal segment and forceps; exposed portions of the wings
h, lined along the median edges with brown. Under
sh-brown.

Measurements.

	♂	♀
Total length,	7.5 mm.	12.0 mm.
Length of pronotum,	1.0 "	1.5 "
Width of pronotum,	1.0 "	1.5 "
Length of anal segment,	.4 "	1.1 "
Length of forceps,	1.5 "	2.5 "

An additional immature specimen from the type locality was also examined.

Genus **ANCISTROGASTER** Stal.

1855. *Ancistrogaster* Stal, Ofv. Kongl.-Vet. Akad. Förh., XII, p. 349.

Type: *A. luctuosus* Stal.

Ancistrogaster tolteca (Scudder).

1876. *Forficula tolteca* Scudder, Proc. Boston Soc. Nat. Hist., XVIII, p. 261 [Mexico.]

Three males; Orizaba, Vera Cruz, Mexico. January 9–16, 1892. (H. Osborn.) [U. S. N. M.]

Previous records: Orizaba and Atoyac, Mexico, and Coban, Guatemala.

Ancistrogaster gulosa Scudder.

1876. *Ancistrogaster gulosa* Scudder, Proc. Boston Soc. Nat. Hist., XVIII, p. 259. [Puebla, Mexico.]

Fifteen specimens; eight males, seven females; Orizaba, Vera Cruz, Mexico. January 9–16, 1892. (H. Osborn.) [U. S. N. M.]

Genus **OPISTHOCOSMIA** Dohrn.

1865. *Opisthocosmia* Dohrn, Entom. Zeitung, Stettin, XXVI, p. 76.

Type: By selection, *O. centurio* Dohrn.

Opisthocosmia (Sarcinatrix) anomalia n. subg. et sp.

Types: ♂ and ♀; Turrialba and San Carlos, Costa Rica. (Schild and Burgdorf.) [U. S. N. M.]

This form appears to differ from all the other members of the genus *Opisthocosmia*, in the forceps of the male being parallel throughout their entire length. This, as well as the peculiar structure of the subgenital plate, has caused me to create a new subgenus for the reception of the species.

♂. Size medium; form rather slender and graceful; surface polished and furnished with long hairs. Head rather broader than the pronotum; interorbital region tumid and bearing two median longitudinal impressions; eyes prominent, ovate in outline; antennæ with the basal joint elongate, robust, of greatest thickness in the distal portion, second

joint very small, less than one-fifth the length of the first, third and fourth joints of equal length which is about one-third that of basal joint, beyond the fourth joint the segments are subcylindrical, gradually increasing in length, the total number being twelve. Pronotum subequal; anterior margin truncate, lateral margins subparallel, posterior broadly rounded; line of depression crossing the median line posterior to the middle; median line shallowly sulcate in the anterior half, slightly carinate in the posterior half. Tegmina broad, shoulder prominent, narrowly rounded; lateral margins subparallel, apical portion very slightly arcuate. Exposed portion of wings rather elongate, over half as long as the tegmina, apex narrowly rounded. Abdomen tapering; basal segments with the lateral folds well developed. Anal segment transverse, posterior margin truncate. Subgenital plate with the postero-lateral angles each produced into a recurved spiniform process, which flank the lateral base of the forceps; posterior margin roundly emarginate. Forceps parallel, simple, tips overlapping; internal borders strongly crenulo-dentate; surface supplied with long hairs. Femora and tibiæ of subequal length, the anterior femora considerably heavier than the median and posterior pair. Tarsi with the third joint heart-shaped, flattened.

General color wood-brown; the median portion of the pronotum, the margins of the tegmina and exposed portions of the wings, the abdomen, forceps and antennal markings of a darker tint than the remainder of the body which is of a sienna tone. Antennæ with the first, second, tenth, eleventh and twelfth dark, the eighth partially so, while the ninth has the basal portion dark, the remainder being cream-colored.

♀. Size medium, larger than the male; form rather robust. Abdomen expanded, the greatest width being median. Anal segment transverse. Subgenital plate produced subtriangular. Forceps practically the same in structure as those of the male, but more elongate and graceful.

General color as in the male. Antennæ with the basal and apical portions of the first, the second, seventh and eighth joints dark.

Measurements.

	♂	♀
Total length,	8.5 mm.	10.5 mm.
Length of pronotum,	1.1 "	1.5 "
Width of pronotum,	1.0 "	1.2 "
Length of tegmina,	2.0 "	2.7 "
Length of forceps,	1.5 "	2.0 "

One additional female from Turrialba was also examined.

Genus NEOLOBOPHORA Scudder.

1875. *Neolobophora* Scudder, Proc. Boston Soc. Nat. Hist., XVII, p. 281.

Type: *N. bogotensis* Scudder.

Neolobophora ruficeps (Burmeister).

1838. *F[orficula] ruficeps* Burmeister, Handb. der Entom., II, p. 755. [Mexico.]

Two specimens; male and female; Orizaba, Vera Cruz, Mexico. January 9–16, 1892. (H. Osborn.) [U. S. N. M.]

The forceps of the female are slenderer than those figured by De Bormans.[4]

Genus APTERYGIDA Westwood.

1840. *Apterygida* Westwood, Introd. Class. Ins. Synop. Gen., p. 44.

Type: *Forficula pedestris* Bon.=*albipennis* Meg.

Apterygida linearis (Eschscholtz).

1822. *Forficula linearis* Eschscholtz, Entomographien, I, p. 81. [Sta. Catharina, Brazil.]

Twenty-three specimens; fifteen males, eight females; Orizaba, Vera Cruz, Mexico. January 9–16, 1892. (H. Osborn.) [U. S. N. M.]

El Guama, Cuba, March 6. (Palmer and Riley.) [U. S. N. M.]

Bonito, Province of Pernambuco, Brazil. (A. Koebele, on cotton.) [U. S. N. M.]

Turrialba, Piedras Negras and San Carlos, Costa Rica. (Schild and Burgdorf.) [U. S. N. M.]

This series of males exhibit considerable variation in the structure of the forceps, in some cases these appendages being constricted centrally. The representatives of this sex range in size from 15 to 20 mm. in total length ; in the females from 10 to 15 mm.

Apterygida californica (Dohrn).

1865. *F[orficula] Californica* Dohrn, Entom. Zeitung, Stettin, XXVI, p. 85. [California.]

Two males:

Orizaba, Vera Cruz, Mexico. January 9–16, 1892. (H. Osborn.) [U. S. N. M.]

Bonito, Province of Pernambuco, Brazil. (A. Koebele, on cotton.) [U. S. N. M.]

While tentatively allowing this form specific rank, I am not at all satisfied that it is more than a mutation of *linearis*, specimens examined being almost intermediate, having the internal tooth reduced to a minimum.

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[4] *Biol. Cent.-Amer.*, Orth., I, Pl. 2, fig. 8.

The specimens above listed are rather smaller than any males in the series of *linearis*, being 14 and 11 mm. in total length.

The previous records for this species are from California, northern Sonora and Teapa, Tabasco, Mexico.

Genus **FORFICULA** Linnæus.

1758. *Forficula* Linnæus, Syst. Nat., X ed., p. 423.

Type: *F. auricularia* Linnæus.

Forficula lugubris Dohrn.

1862. *Forficula lugubris* Dohrn, Entom. Zeitung, Stettin, XXIV, p. 230 [Cordova, Mexico.]

Eleven specimens; four males, seven females; Orizaba, Vera Cruz, Mexico. (H. Osborn.) [U. S. N. M.]

These specimens differ from the original description in their more reddish coloration.

The previous records for this species cover from Durango, Mexico, to Valladolid, Yucatan, and Vera Paz, Guatemala.

Forficula metrica n. sp.

Type: ♂; Orizaba, Vera Cruz, Mexico. January 9–16, 1892. (H. Osborn.) [U. S. N. M.]

Closely allied to *F. lugubris* Dohrn, but differing in the longer forceps, which also bear an elongate low ridge on their internal upper surface, instead of a comparatively high rounded projection as in *lugubris*.

Size medium; form rather robust; surface glabrous, sparsely supplied with short hairs. Head about equal to the pronotum in width; interspace between the eyes rather tumid; antennæ with but six joints present, the basal one moderately robust, the third to sixth of simple form, slightly increasing in length distally. Pronotum slightly broader than long; anterior border truncate, lateral borders slightly arcuate, the posterior subtruncate, the postero-lateral angles very broadly rounded; line of depression but slightly marked and crossing about the middle; median line shallowly sulcate anteriorly, narrowly carinate posteriorly. Elytra of moderate width; shoulder well rounded and not at all prominent; lateral margins parallel; posterior margin subtruncate. Exposed portion of wings half as long as the tegmina, rounded. Abdomen with the median section considerably expanded; two median segments with the lateral folds developed, the posterior the heavier. Anal segment transverse, the posterior margin subarcuate. Subgenital plate broadly triangular, the apex truncate. Forceps almost equal to the remainder of the body in length; the basal fourth parallel, depressed and bearing a lamellate ridge along the internal

margin; apical three-fourths arcuate, unarmed. Pygidium very short, subacuminate. Median and posterior limbs with the femora and tibiæ of subequal length; anterior limbs with the tibiæ distinctly exceeding the femora.

General color dark-brown; antennæ and limbs gamboge-yellow.

Measurements.

Total length,	17.0 mm.
Length of pronotum,	1.7 "
Width of pronotum,	2.0 "
Length of tegmina,	3.0 "
Length of anal segment	1.0 "
Anterior width of of anal segment,	2.0 "
Length of forceps,	7.5 "

A NOTE ON THE COMMON BOTTLENOSED PORPOISE OF THE NORTH ATLANTIC, TURSIOPS TRUNCATUS (Montagu).

BY FREDERICK W. TRUE.

The common *Tursiops* of the North Atlantic is generally known in ientific parlance as *Tursiops tursio* (Fabricius), taking its specific ıme from the *Delphinus tursio* of Fabricius. During a recent study Fabricius' species I became convinced that whatever his *D. tursio* ight be it was not the bottlenosed porpoise, so common on the Atlan- : coast of the United States.

The original description by Fabricius has been learnedly discussed ' Eschricht, Holböll, Robert Brown, and others with the view of termining if possible what it really represents, but the principal con- rn here is to determine what it does *not* represent.

After describing the head of his *D. tursio*, Fabricius proceeds as lows: "Teeth in both jaws distant, with obtuse apex, as in *Del- inus albicans* [=*Delphinapterus leucas*], but larger. Body very thick, in *Boops* [*i.e.*, humpback whale] and equal with the young of the ter."[1]

Now the teeth of the common bottlenosed porpoise are not far apart, d are acute except in old individuals, and are smaller than those of *lphinapterus*. But most significant of all is the remark that the dy equals that of the young of the humpback whale. The young of s whale has a length of from 14 to 18 feet *at birth*, which proportions never reached by the adult bottlenosed porpoise.

Taking these facts into consideration it would seem out of the ques- n to apply Fabricius' name to our common porpoise. The Green- ıdic name reported by Fabricius for his species was *Nesarnak*. chricht states that this word means simply "resembling the Nisa." *sa* is a name for porpoise adopted by the Greenlanders from the andinavian colonists.[2]

Capt. Holböll had previously stated that the natives appeared to signate the blackfish, *Globicephala*, by this name, but certainly not porpoise currently known as *D. tursio*.[3]

In 1868, Robert Brown, in treating of the cetaceans of Greenland, narked under the head of *Globicephala:* "There seems little doubt

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[1] FABRICIUS, *Fauna Grœnlandica*, 1780, p. 49.
[2] *Ann. Sci. Nat.*, 5e ser., Zool., I, 1864, p. 209.
[3] HOLBÖLL in Eschricht's *Untersuch. über nord. Wallthiere*, 1849, p. 190.

that this is the *Delphinus tursio* of Fabricius, as the Eskimo name *Nesarnak* is applied to the present animal." Finally, to clinch the matter, he states that Montagu's *Delphinus truncatus* (*i.e.*, the bottlenosed porpoise) "has never been found in Davis Strait."[4]

I am unable to find reference to any Greenland specimens of *Tursiops* in the museums of Europe and there are none in the U. S. National Museum.

The correct name for the bottlenosed porpoise is probably *Tursiops truncatus* (Montagu), from the *Delphinus truncatus* described by Montagu in 1821.[5] The specific name *truncatus* has been employed from time to time by various systematists, including J. E. Gray, but Beddard and other recent compilers have generally made use of the inapplicable *tursio*.

There is a possibility that the *Delphinus siculus* of Rafinesque, described in 1810, is the same as *Tursiops truncatus*, in which case *siculus* would have priority, but Rafinesque's description is so insufficient that there will probably always be a difference of opinion as to the identity of his species. Under the circumstances it seems unwise to give it serious consideration. Rafinesque's description (translated) is as follows:

"**Delphinus siculus.**

"Body oblong, attenuated posteriorly, bluish above, white below; rostrum short, obtuse; teeth equally obtuse. *Remarks:* This dolphin is called '*Fera*' in Sicily, and has much affinity with *Delphinus feres* of Bonnaterre, but that is black and has the teeth unequal, alternately longer and shorter. Both differ from *D. phocena* and *D. delphis*, which have the teeth acute, and the last the rostrum also."[6]

Later writers on the fauna of Sicily, so far as I have observed, do not mention the "fera" among the species of porpoises, but Carus states that the common porpoise, or dolphin, *Delphinus delphis*, is known to the Sicilians as "fera comune," so that there is a probability that *Tursiops truncatus* might be known as "fera." The *Delphinus feres* of Bonnaterre is certainly not the same as *Tursiops truncatus*, as the skeleton of one was 14 feet long, the skull 22½ inches long and 17 inches broad, the total number of teeth but 40, and the skin entirely black. It was probably a species of *Globicephala*.

[4] *Arctic Manual*, 1875, pp. 91–92, from P. Z. S., 1868, with additions and corrections.

[5] MONTAGU, GEO., "Description of a Species of Delphinus which appears to be New," *Mem. Wernerian Soc. Nat. Hist.*, 3, 1821, pp. 75–82, 1 Pl.

[6] RAFINESQUE-SCHMALTZ, C. S., *Caratteri eri di alcuni nuovi gen. et sp. anim. et piant. della Sicilia*, 1810, p. 5.

ADDITIONS TO THE JAPANESE LAND SNAIL FAUNA—No. VIII.

BY HENRY A. PILSBRY.

Several new forms of *Clausilia* have been detected by Mr. Hirase since the publication of No. VII of this series.[1] They are chiefly from Shikoku Island, and all belong to groups already well represented in the same regions. A single species herein described from Sado is the first *Clausilia* to be made known from that island.

Section HEMIPHÆDUSA Bttg.

(*Group of C. awajiensis.*)

Clausilia sadoensis n. sp. Pl. XIV, figs. 6, 7, 8, 9, 10.

Shell *slender*, attenuate above, brown. Surface somewhat glossy, finely striate, paler and smoother above, hardly more coarsely striate on the last whorl. Whorls $10\frac{1}{2}$ to 11, convex, the last compressed laterally, and having *a rounded ridge or varix behind the basal and outer lips*. Aperture small; peristome white, reflexed, continuous, the parietal margin erect and free. Superior lamella compressed, marginal, continuous with the spiral lamella or interrupted. Spiral lamella short, not quite reaching the middle of the ventral side. Inferior lamella deeply receding, straightened within, *as long as the spiral lamella*. Subcolumella lamellar emerging but weak. Principal plica short, latero-dorsal. Upper palatal plica short, in the middle joined to the long, nearly straight lunella, which curves inward slightly toward the lower end.

Length 15.5 to 16, diam. 3.5 mm.

Length 14, diam. 3.5 mm.

Clausilium long, parallel-sided, rounded apically, deeply excised on the columellar side of the filament (figs. 8, 9).

Misakimura, Sado. Types No. 84,394, A. N. S. P., from No. 993 of Mr. Hirase's collection.

Closely related to *C. ischna*, especially to the variation of that species which I called var. *neptis*, but *C. sadoensis* differs in the stronger ridge behind the lip (barely indicated or not perceptible in *C. ischna*), and in having the spiral and inferior lamellæ of equal length inside, while in

[1] These *Proceedings* for 1902, pp. 517–533.

ischna and *neptis* the spiral lamella penetrates decidedly farther than the inferior lamella.

Clausilia shikokuensis var. inokuchiensis nov.

Smaller than *shikokuensis*, orange-brown; whorls 9½, the early ones attenuate. Length 13, diam. 3.2 mm.

Inokuchimura, Tosa; No. 84,391, A. N. S. P., from No. 506c of Mr. Hirase's collection.

A small reddish form, very solid and strong, but structurally like the larger brown *C. shikokuensis*.

Clausilia sus n. sp. Pl. XIV, figs. 1, 2, 3, 4, 5.

Shell quite obesely fusiform, attenuate above, orange-brown, solid and strong, somewhat glossy, finely striate. Whorls 8½, moderately convex, the last compressed laterally. Aperture only slightly oblique, the peristome expanded and reflexed, somewhat thickened, orange-brown or whitish, a little emarginate at the position of the superior lamella. Superior lamella compressed, subvertical and marginal, continuous with the spiral lamella, which penetrates to a point above the superior lamella. Inferior lamella deeply receding, thick below, penetrating as deeply as the spiral lamella. Subcolumellar lamella wholly immersed or very weakly emerging. Principal plica visible deep in the throat, entering to a lateral position. Upper palatal plica very short and small, almost obsolete. Lunella strong and a little curved inward below, very weak and low above, where it connects with the middle of the upper palatal plica.

Length 11.5, diam. 3.7 mm.

Length 11, diam. 3.5 mm.

Clausilium (Pl. XIV, figs. 2, 3) parallel-sided, thin and acute at the apex, excised on the columellar side of the filament.

Muya, Awa, Shikoku Island. Types No. 84,393, A. N. S. P., from No. 1,007 of Mr. Hirase's collection.

The obese shape of the shell and slightly curved lunella, very strong below and weak above, are characteristic, and the acuminate, acute apex of the clausilium equally so. Some specimens are less swollen, length 12, diam. 3.3 mm. It is not closely related to any other species I have seen, but groups with *C. shikokuensis*.

(Group of C. validiuscula.)

Clausilia aratorum n. sp. Pl. XIV, figs. 15, 16, 17, 18.

Shell small, slender and thin, light brown and slightly transparent. Surface glossy, coarsely sculptured with strong, regular, straight striæ. Apical whorls smooth, rather large. Whorls 9, somewhat convex, the

last somewhat compressed, very shortly projecting in front. Aperture slightly oblique, the peristome continuous, narrowly reflexed, but little thickened. Superior lamella marginal, thin and compressed, separated from the spiral lamella, which extends inward to the middle of the front side. Inferior lamella deeply receding, thin and straightly ascending within, penetrating deeper than the spiral lamella. Subcolumellar lamella deeply immersed. Principal plica hardly a third of a whorl long, latero-dorsal. Upper palatal plica short and low, a low, short, nearly straight lunella connected with it.

Length 9.5, diam. 2 mm.

Length 8.5, diam. 1.8 mm.

Clausilium long and narrow, rounded distally, excavated on the columellar side of the filament. It is very similar to that of *C. ænea*, but tapers less distally (figs. 17, 18).

Shimohanyama, Tosa, Shikoku Island. Types No. 84,438, A. N. S. P., from No. 1,013 of Mr. Hirase's collection.

This small, thin, rib-striate species seems by its palatal armature to be related somewhat to *C. micropeas*, but in all other respects it resembles the slightly larger *C. ænea* which was found with it. Both may be more nearly related to *C. tosana* than to other described species. The lunella in *C. aratorum* is very weak except close to the upper palatal plica, where it becomes stronger; and in some shells only this stronger portion is present, making with the plica an irregularly triangular callous, without the extension downward shown in the figure. I can see no trace of a lower palatal plica. The subcolumellar lamella has no spiral extension within, on the ventral side of the penult. whorl parallel to the spiral and inferior lamellæ, in either this species or *C. ænea*.

Clausilia ænea n. sp. Pl. XIV, figs. 11, 12, 13, 14.

Shell slender, fusiform, brown with a bronzed luster, the surface closely, strongly striate. Whorls 9½, convex, the last somewhat compressed laterally. Aperture slightly oblique, piriform, the peristome thin, free, expanded and slightly reflexed, somewhat emarginate above. Superior lamella thin, compressed, vertical, almost separated from the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella deeply receding, thin and straightly ascending within, as long as the spiral lamella. Subcolumellar lamella deeply immersed. Principal plica short, dorso-lateral. Upper and lower palatal plicæ short, parallel, connected by a low ridge upon which there are three low tubercles.

Length 12.5, diam. 2.5 mm.

Length 11, diam. 2.3 mm.

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Hirase's collection.

A small reddish form, very solid and strong, but structurally lik
the larger brown *C. shikokuensis*.

Clausilia sus n. sp. Pl. XIV, figs. 1, 2, 3, 4, 5.

Shell quite obesely fusiform, attenuate above, orange-brown, solid
and strong, somewhat glossy, finely striate. Whorls 8½, moderately
convex, the last compressed laterally. Aperture only slightly oblique,
the peristome expanded and reflexed, somewhat thickened, orange-
brown or whitish, a little emarginate at the position of the superior
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deep in the throat, entering to a lateral position. Upper palatal plica
very short and small, almost obsolete. Lunella strong and a little
curved inward below, very weak and low above, where it connects
with the middle of the upper palatal plica.

Length 11.5, diam. 3.7 mm.

Length 11, diam. 3.5 mm.

Clausilium (Pl. XIV, figs. 2, 3) parallel-sided, thin and acute at
apex, excised on the columellar side of the filament.

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Length 9.5, diam. 2 mm.

Length 8.5, diam. 1.8 mm.

Clausilium long and narrow, rounded distally, excavated on the columellar side of the filament. It is very similar to that of *C. ænea*, but tapers less distally (figs. 17, 18).

Shimohanyama, Tosa, Shikoku Island. Types No. 84,438, A. N. S. P., from No. 1,013 of Mr. Hirase's collection.

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Clausilia ænea n. sp. Pl. XIV, figs. 11, 12, 13, 14.

Shell slender, fusiform, brown with a bronzed luster, the surface closely, strongly striate. Whorls 9½, convex, the last somewhat compressed laterally. Aperture slightly oblique, piriform, the peristome thin, free, expanded and slightly reflexed, somewhat emarginate above. Superior lamella thin, compressed, vertical, almost separated from the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella deeply receding, thin and straightly ascending within, as long as the spiral lamella. Subcolumellar lamella deeply immersed. Principal plica short, dorso-lateral. Upper and lower palatal plicæ short, parallel, connected by a low ridge upon which there are three low tubercles.

Length 12.5, diam. 2.5 mm.

Length 11, diam. 2.3 mm.

ischna and *neptis* the spiral lamella penetrates decidedly farther than the inferior lamella.

Clausilia shikokuensis var. inokuchiensis nov.

Smaller than *shikokuensis*, orange-brown; whorls 9½, the early ones attenuate. Length 13, diam. 3.2 mm.

Inokuchimura, Tosa; No. 84,391, A. N. S. P., from No. 506c of Mr. Hirase's collection.

A small reddish form, very solid and strong, but structurally like the larger brown *C. shikokuensis*.

Clausilia sus n. sp. Pl. XIV, figs. 1, 2, 3, 4, 5.

Shell quite obesely fusiform, attenuate above, orange-brown, solid and strong, somewhat glossy, finely striate. Whorls 8½, moderately convex, the last compressed laterally. Aperture only slightly oblique, the peristome expanded and reflexed, somewhat thickened, orange-brown or whitish, a little emarginate at the position of the superior lamella. Superior lamella compressed, subvertical and marginal, continuous with the spiral lamella, which penetrates to a point above the superior lamella. Inferior lamella deeply receding, thick below penetrating as deeply as the spiral lamella. Subcolumellar lamell wholly immersed or very weakly emerging. Principal plica visib deep in the throat, entering to a lateral position. Upper palatal pli very short and small, almost obsolete. Lunella strong and a lit curved inward below, very weak and low above, where it conne with the middle of the upper palatal plica.

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(Group of C. validiuscula.)

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Shell small, slender and thin, light brown and slightly transpar nt. Surface glossy, coarsely sculptured with strong, regular, straight st iæ. Apical whorls smooth, rather large. Whorls 9, somewhat convex, the

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Length 9.5, diam. 2 mm.

Length 8.5, diam. 1.8 mm.

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Clausilia ænea n. sp. Pl. XIV, figs. 11, 12, 13, 14.

Shell slender, fusiform, brown with a bronzed luster, the surface closely, strongly striate. Whorls 9½, convex, the last somewhat compressed laterally. Aperture slightly oblique, piriform, the peristome thin, free, expanded and slightly reflexed, somewhat emarginate above. Superior lamella thin, compressed, vertical, almost separated from the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella deeply receding, thin and straightly ascending within, as long as the spiral lamella. Subcolumellar lamella deeply immersed. Principal plica short, dorso-lateral. Upper and lower palatal plicæ short, parallel, connected by a low ridge upon which there are three low tubercles.

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A small reddish form, very solid and strong, but structurally lik[illegible] the larger brown *C. shikokuensis*.

Clausilia sus n. sp. Pl. XIV, figs. 1, 2, 3, 4, 5.

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Clausilia aratorum n. sp. Pl. XIV, figs. 15, 16, 17, 18.

Shell small, slender and thin, light brown and slightly transpa[illegible]en Surface glossy, coarsely sculptured with strong, regular, straight s[illegible]ria [illegible] whorls smooth, rather large. Whorls 9, somewhat convex, [illegible]th

last somewhat compressed, very shortly projecting in front. Aperture slightly oblique, the peristome continuous, narrowly reflexed, but little thickened. Superior lamella marginal, thin and compressed, separated from the spiral lamella, which extends inward to the middle of the front side. Inferior lamella deeply receding, thin and straightly ascending within, penetrating deeper than the spiral lamella. Subcolumellar lamella deeply immersed. Principal plica hardly a third of a whorl long, latero-dorsal. Upper palatal plica short and low, a low, short, nearly straight lunella connected with it.

Length 9.5, diam. 2 mm.

Length 8.5, diam. 1.8 mm.

Clausilium long and narrow, rounded distally, excavated on the columellar side of the filament. It is very similar to that of *C. ænea*, but tapers less distally (figs. 17, 18).

Shimohanyama, Tosa, Shikoku Island. Types No. 84,438, A. N. S. P., from No. 1,013 of Mr. Hirase's collection.

This small, thin, rib-striate species seems by its palatal armature to be related somewhat to *C. micropeas*, but in all other respects it resembles the slightly larger *C. ænea* which was found with it. Both may be more nearly related to *C. tosana* than to other described species. The lunella in *C. aratorum* is very weak except close to the upper palatal plica, where it becomes stronger; and in some shells only this stronger portion is present, making with the plica an irregularly triangular callous, without the extension downward shown in the figure. I can see no trace of a lower palatal plica. The subcolumellar lamella has no spiral extension within, on the ventral side of the penult. whorl parallel to the spiral and inferior lamellæ, in either this species or *C. ænea*.

Clausilia ænea n. sp. Pl. XIV, figs. 11, 12, 13, 14.

Shell slender, fusiform, brown with a bronzed luster, the surface closely, strongly striate. Whorls 9½, convex, the last somewhat compressed laterally. Aperture slightly oblique, piriform, the peristome thin, free, expanded and slightly reflexed, somewhat emarginate above. Superior lamella thin, compressed, vertical, almost separated from the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella deeply receding, thin and straightly ascending within, as long as the spiral lamella. Subcolumellar lamella deeply immersed. Principal plica short, dorso-lateral. Upper and lower palatal plicæ short, parallel, connected by a low ridge upon which there are three low tubercles.

Length 12.5, diam. 2.5 mm.

Length 11, diam. 2.3 mm.

ischna and *neptis* the spiral lamella penetrates decidedly farther than the inferior lamella.

Clausilia shikokuensis var. inokuchiensis nov.

Smaller than *shikokuensis*, orange-brown; whorls 9½, the early ones attenuate. Length 13, diam. 3.2 mm.

Inokuchimura, Tosa; No. 84,391, A. N. S. P., from No. 506*c* of Mr. Hirase's collection.

A small reddish form, very solid and strong, but structurally like the larger brown *C. shikokuensis*.

Clausilia sus n. sp. Pl. XIV, figs. 1, 2, 3, 4, 5.

Shell quite obesely fusiform, attenuate above, orange-brown, solid and strong, somewhat glossy, finely striate. Whorls 8½, moderately convex, the last compressed laterally. Aperture only slightly oblique, the peristome expanded and reflexed, somewhat thickened, orange-brown or whitish, a little emarginate at the position of the superior lamella. Superior lamella compressed, subvertical and marginal, continuous with the spiral lamella, which penetrates to a point above the superior lamella. Inferior lamella deeply receding, thick below, penetrating as deeply as the spiral lamella. Subcolumellar lamella wholly immersed or very weakly emerging. Principal plica visible deep in the throat, entering to a lateral position. Upper palatal plica very short and small, almost obsolete. Lunella strong and a little curved inward below, very weak and low above, where it connects with the middle of the upper palatal plica.

Length 11.5, diam. 3.7 mm.

Length 11, diam. 3.5 mm.

Clausilium (Pl. XIV, figs. 2, 3) parallel-sided, thin and acute at the apex, excised on the columellar side of the filament.

Muya, Awa, Shikoku Island. Types No. 84,393, A. N. S. P., from No. 1,007 of Mr. Hirase's collection.

The obese shape of the shell and slightly curved lunella, very strong below and weak above, are characteristic, and the acuminate, acute apex of the clausilium equally so. Some specimens are less swollen, length 12, diam. 3.3 mm. It is not closely related to any other species I have seen, but groups with *C. shikokuensis*.

(Group of C. validiuscula.)

Clausilia aratorum n. sp. Pl. XIV, figs. 15, 16, 17, 18.

Shell small, slender and thin, light brown and slightly transparent. Surface glossy, coarsely sculptured with strong, regular, straight striæ. Apical whorls smooth, rather large. Whorls 9, somewhat convex, the

omewhat compressed, very shortly projecting in front. Aper- lightly oblique, the peristome continuous, narrowly reflexed, but thickened. Superior lamella marginal, thin and compressed, ated from the spiral lamella, which extends inward to the middle e front side. Inferior lamella deeply receding, thin and straightly iding within, penetrating deeper than the spiral lamella. Sub- nellar lamella deeply immersed. Principal plica hardly a third whorl long, latero-dorsal. Upper palatal plica short and low, a short, nearly straight lunella connected with it.

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ngth 8.5, diam. 1.8 mm.

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Smaller than *shikokuensis*, orange-brown; whorls 9½, the early ones attenuate. Length 13, diam. 3.2 mm.

Inokuchimura, Tosa; No. 84,391, A. N. S. P., from No. 506*c* of Mr. Hirase's collection.

A small reddish form, very solid and strong, but structurally like the larger brown *C. shikokuensis*.

Clausilia sus n. sp. Pl. XIV, figs. 1, 2, 3, 4, 5.

Shell quite obesely fusiform, attenuate above, orange-brown, solid and strong, somewhat glossy, finely striate. Whorls 8½, moderately convex, the last compressed laterally. Aperture only slightly oblique, the peristome expanded and reflexed, somewhat thickened, orange-brown or whitish, a little emarginate at the position of the superior lamella. Superior lamella compressed, subvertical and marginal, continuous with the spiral lamella, which penetrates to a point above the superior lamella. Inferior lamella deeply receding, thick below, penetrating as deeply as the spiral lamella. Subcolumellar lamella wholly immersed or very weakly emerging. Principal plica visible deep in the throat, entering to a lateral position. Upper palatal plica very short and small, almost obsolete. Lunella strong and a little curved inward below, very weak and low above, where it connects with the middle of the upper palatal plica.

Length 11.5, diam. 3.7 mm.

Length 11, diam. 3.5 mm.

Clausilium (Pl. XIV, figs. 2, 3) parallel-sided, thin and acute at the apex, excised on the columellar side of the filament.

Muya, Awa, Shikoku Island. Types No. 84,393, A. N. S. P., from No. 1,007 of Mr. Hirase's collection.

The obese shape of the shell and slightly curved lunella, very strong below and weak above, are characteristic, and the acuminate, acute apex of the clausilium equally so. Some specimens are less swollen, length 12, diam. 3.3 mm. It is not closely related to any other species I have seen, but groups with *C. shikokuensis*.

(Group of C. validiuscula.)

Clausilia aratorum n. sp. Pl. XIV, figs. 15, 16, 17, 18.

Shell small, slender and thin, light brown and slightly transparent. Surface glossy, coarsely sculptured with strong, regular, straight striæ. Apical whorls smooth, rather large. Whorls 9, somewhat convex, the

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Clausilia shikokuensis var. inokuchiensis nov.

Smaller than *shikokuensis*, orange-brown; whorls 9½, the early ones attenuate. Length 13, diam. 3.2 mm.

Inokuchimura, Tosa; No. 84,391, A. N. S. P., from No. 506*c* of Mr. Hirase's collection.

A small reddish form, very solid and strong, but structurally like the larger brown *C. shikokuensis*.

Clausilia sus n. sp. Pl. XIV, figs. 1, 2, 3, 4, 5.

Shell quite obesely fusiform, attenuate above, orange-brown, solid and strong, somewhat glossy, finely striate. Whorls 8½, moderately convex, the last compressed laterally. Aperture only slightly oblique, the peristome expanded and reflexed, somewhat thickened, orange-brown or whitish, a little emarginate at the position of the superior lamella. Superior lamella compressed, subvertical and marginal, continuous with the spiral lamella, which penetrates to a point above the superior lamella. Inferior lamella deeply receding, thick below, penetrating as deeply as the spiral lamella. Subcolumellar lamella wholly immersed or very weakly emerging. Principal plica visible deep in the throat, entering to a lateral position. Upper palatal plica very short and small, almost obsolete. Lunella strong and a little curved inward below, very weak and low above, where it connects with the middle of the upper palatal plica.

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Clausilium (Pl. XIV, figs. 2, 3) parallel-sided, thin and acute at the apex, excised on the columellar side of the filament.

Muya, Awa, Shikoku Island. Types No. 84,393, A. N. S. P., from No. 1,007 of Mr. Hirase's collection.

The obese shape of the shell and slightly curved lunella, very strong below and weak above, are characteristic, and the acuminate, acute apex of the clausilium equally so. Some specimens are less swollen, length 12, diam. 3.3 mm. It is not closely related to any other species I have seen, but groups with *C. shikokuensis*.

(Group of C. validiuscula.)

Clausilia aratorum n. sp. Pl. XIV, figs. 15, 16, 17, 18.

Shell small, slender and thin, light brown and slightly transparent. Surface glossy, coarsely sculptured with strong, regular, straight striæ. Apical whorls smooth, rather large. Whorls 9, somewhat convex, the

last somewhat compressed, very shortly projecting in front. Aperture slightly oblique, the peristome continuous, narrowly reflexed, but little thickened. Superior lamella marginal, thin and compressed, separated from the spiral lamella, which extends inward to the middle of the front side. Inferior lamella deeply receding, thin and straightly ascending within, penetrating deeper than the spiral lamella. Subcolumellar lamella deeply immersed. Principal plica hardly a third of a whorl long, latero-dorsal. Upper palatal plica short and low, a low, short, nearly straight lunella connected with it.

Length 9.5, diam. 2 mm.

Length 8.5, diam. 1.8 mm.

Clausilium long and narrow, rounded distally, excavated on the columellar side of the filament. It is very similar to that of *C. ænea*, but tapers less distally (figs. 17, 18).

Shimohanyama, Tosa, Shikoku Island. Types No. 84,438, A. N. S. P., from No. 1,013 of Mr. Hirase's collection.

This small, thin, rib-striate species seems by its palatal armature to be related somewhat to *C. micropeas*, but in all other respects it resembles the slightly larger *C. ænea* which was found with it. Both may be more nearly related to *C. tosana* than to other described species. The lunella in *C. aratorum* is very weak except close to the upper palatal plica, where it becomes stronger; and in some shells only this stronger portion is present, making with the plica an irregularly triangular callous, without the extension downward shown in the figure. I can see no trace of a lower palatal plica. The subcolumellar lamella has no spiral extension within, on the ventral side of the penult. whorl parallel to the spiral and inferior lamellæ, in either this species or *C. ænea*.

Clausilia ænea n. sp. Pl. XIV, figs. 11, 12, 13, 14.

Shell slender, fusiform, brown with a bronzed luster, the surface closely, strongly striate. Whorls 9½, convex, the last somewhat compressed laterally. Aperture slightly oblique, piriform, the peristome thin, free, expanded and slightly reflexed, somewhat emarginate above. Superior lamella thin, compressed, vertical, almost separated from the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella deeply receding, thin and straightly ascending within, as long as the spiral lamella. Subcolumellar lamella deeply immersed. Principal plica short, dorso-lateral. Upper and lower palatal plicæ short, parallel, connected by a low ridge upon which there are three low tubercles.

Length 12.5, diam. 2.5 mm.

Length 11, diam. 2.3 mm.

Clausilium (Pl. XIV, figs. 11, 12) long and narrow, widest and projecting a little on each side near the filament, tapering distally; excised on the columellar side of the filament.

Shimohanyama, Tosa, Shikoku. Types No. 84,392, A. N. S. P., from No. 1,014 of Mr. Hirase's collection.

Similar to *C. aratorum* in sculpture, aperture and lamellæ, but having a distinct lower palatal plica and a low lunella upon which several low plicæ are seen, in this respect resembling *C. tosana*. The latter is a more finely striate shell with the last whorl projecting more in front, and the clausilium of a different shape.

(*Group of C. platyauchen.*)

Clausilia platyderula n. sp.

Shell similar to *C. platydera*, but much smaller; brown; finely and sharply striate. Superior lamella compressed, marginal, continuous with the spiral lamella, which penetrates past the ventral side. The inferior lamella penetrates equally far. The subcolumellar lamella emerges at least slightly. The lunella is like that of *platydera*.

Length 17, diam. 3.8 mm.

Length 15, diam. 3.3 mm.

Aki, Tosa, Shikoku Island. Types No. 84,443, A. N. S. P., from No. 434*d* of Mr. Hirase's collection.

It will be figured in a general review of the species of the *platyauchen* group, in preparation.

Section TYRANNOPHÆDUSA Pils.

Clausilia bilabrata var. **tosaensis** nov.

A small form with the shell very strong, the spire *entire*, and the aperture comparatively small, its greatest length contained 4½ times in that of the shell; superior and spiral lamellæ not united or but weakly so. Whorls about 12.

Length 20, diam. 4.3 to 4.8 mm.

Shiujōmura, Tosa, Types No. 84,378, A. N. S. P., from No. 1,012 of Mr. Hirase's collection.

Section STEREOPHÆDUSA Bttg.

Clausilia echigoensis n. sp.

Shell wide below, rapidly tapering upward, attenuate near the apex, several early whorls hardly increasing in diameter, making the outlines concave above; dark chestnut colored, yellow or paler below the suture.

Surface *very glossy*, sculptured with *coarse, oblique ribs*, narrower

than their intervals, becoming finer and then disappearing on the early whorls; the intervals between the ribs more or less crinkled. Whorls 11, moderately convex, the last half of the last whorl flattened and compressed, rounded beneath. Suture marked with a fine white line. Aperture nearly vertical, dark inside, the peristome white, narrowly reflexed. Superior lamella small and low, narrow, not continuous with the spiral lamella, barely reaching the margin or not reaching it. Spiral lamella short, not quite reaching the middle of the ventral side. Inferior lamella forming a strong fold in the aperture, becoming subhorizontal, strongly spiral within, a little longer than the spiral lamella. Subcolumellar lamella barely emerging or immersed. Principal plica quite short, latero-dorsal. Upper palatal plica lateral, short. Lower palatal plica shorter, oblique. No lunella.

Length 28.7, diam. 7.7–8 mm.

Clausilium wide, thickened and somewhat angular at the apex, somewhat excised on the columellar side of the filament.

Myokozan, Echigo. Types No. 84,444, A. N. S. P., from No. 986 of Mr. Hirase's collection.

Belonging to the *C. japonica* group, this species seems well distinguished by its robust shape and very strong sculpture. It will be figured with the other species of the *japonica* group of *Stereophædusæ*, in a revision of them now in preparation.

Clausilia japonica var. perstriata nov.

Similar to *japonica* except in sculpture, the surface being strongly, deeply and closely rib-striate.

Kumanogongen, Echigo. Types No. 84,376, A. N. S. P., from No. 986*a* of Mr. Hirase's collection.

Explanation of Plate XIV.

Figs. 1, 2, 3, 4.—*Clausilia sus* n. sp. Typical form.
Fig. 5.—*Clausilia sus*, a more attenuate variation occurring with the preceding.
Figs. 6–10.—*Clausilia sadoensis*, n. sp.
Figs. 11–14.—*Clausilia ænea* n. sp.
Figs. 15–18.—*Clausilia aratorum* n. sp.

LIFE COLORS OF PŒCILIA LIMANTOURI, AND DESCRIPTION OF A NEW HEROS FROM MEXICO.

BY HENRY W. FOWLER.

The Academy has received a small collection of fishes from Tamaulipas, Mexico. They were secured January 16 by Mr. S. N. Rhoads while on his recent visit to Mexico, in the warm waters of the Victoria river near Victoria. This is a small stream tributary of the Rio Soto la Marina, at the foothills of the Sierra Madre Mountains in western Tamaulipas.

The material is in excellent condition, so that it is possible to give the life colors of the *Pœcilia*, which were unknown.

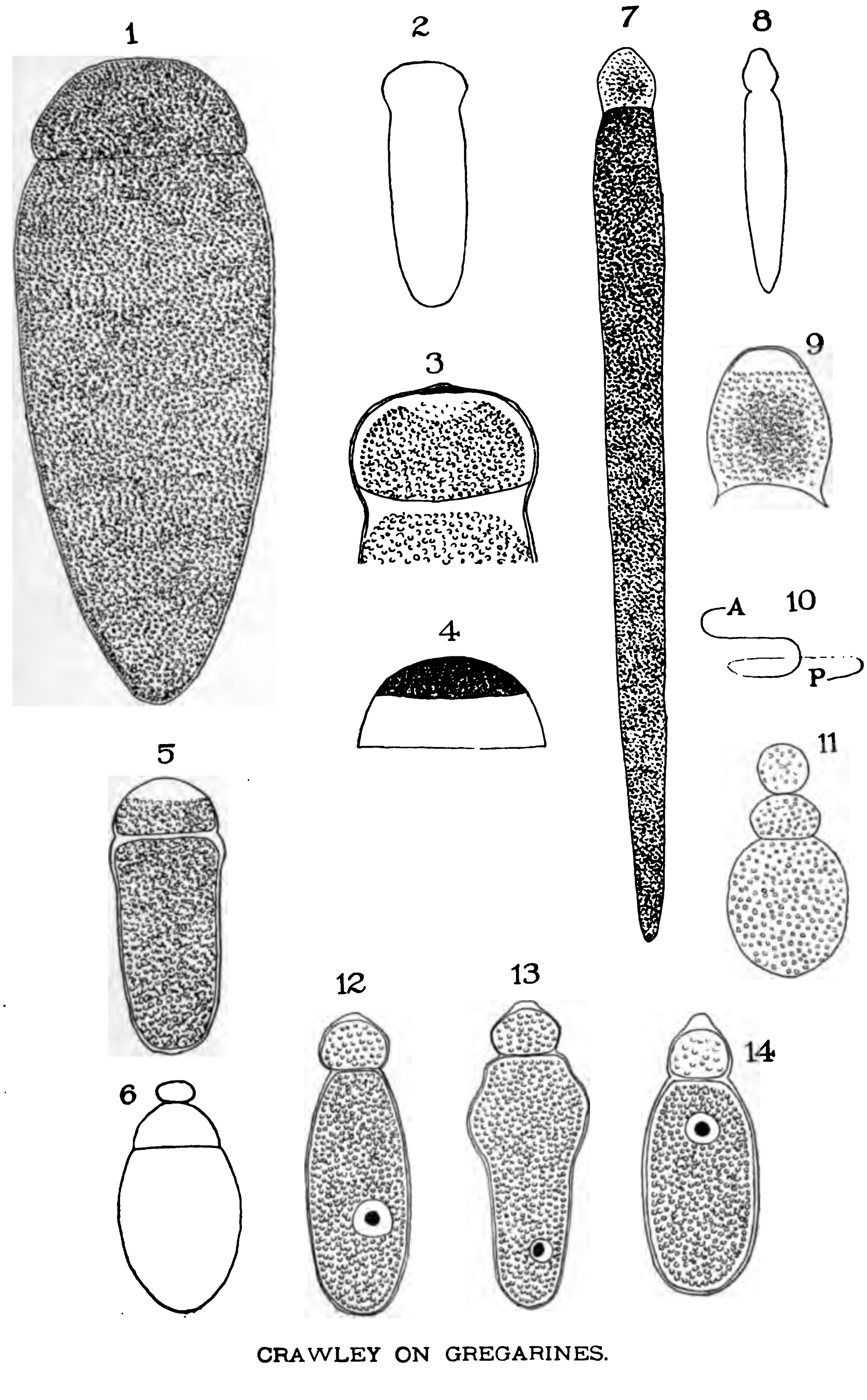
PŒCILIIDÆ.

1. Pœcilia limantouri Jordan and Snyder.

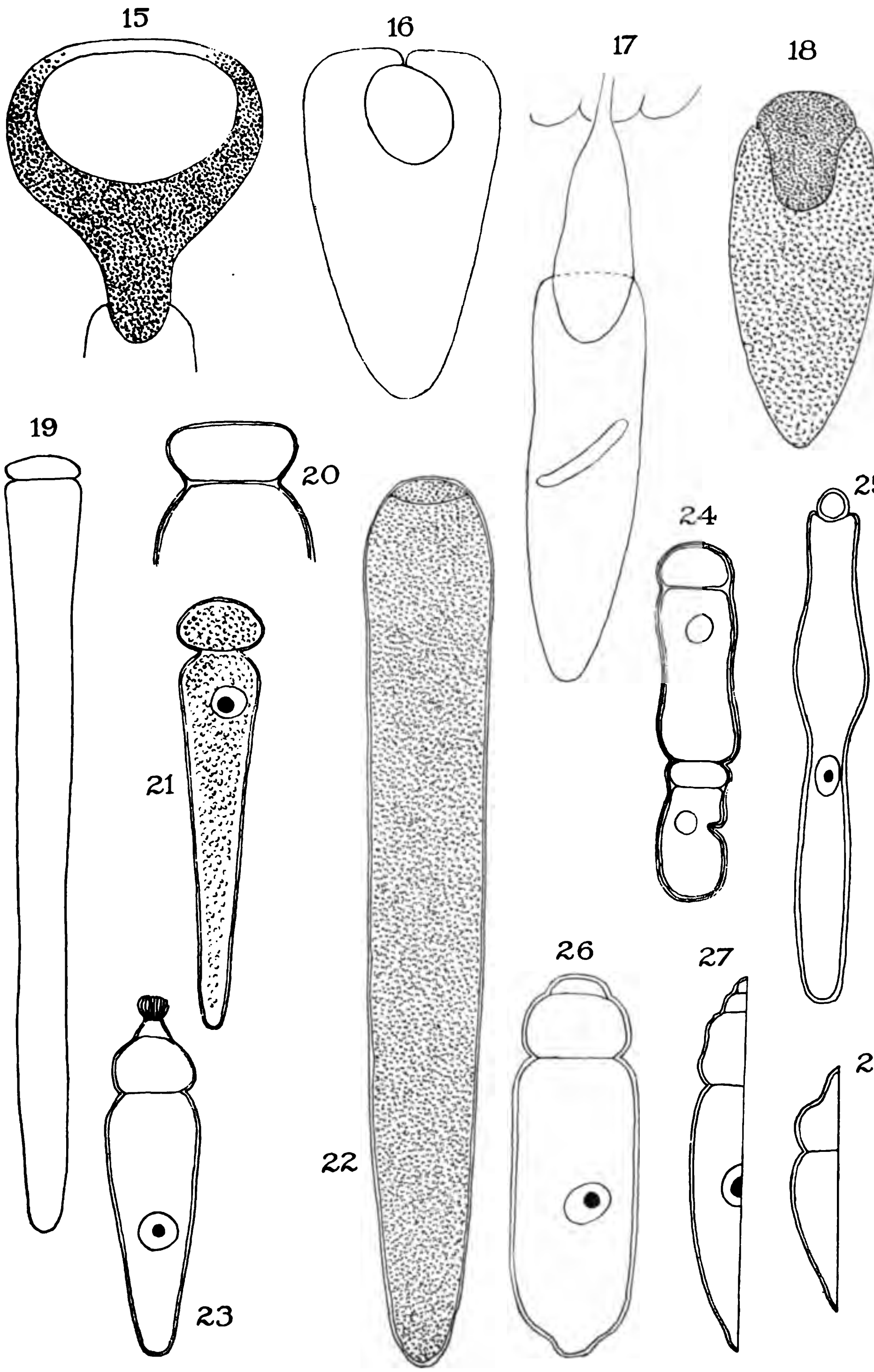
1900. *Pœcilia limantouri* Jordan and Snyder, Bull. U. S. Fish Comm., p. 129, fig. 10; Rio Tamesoe, near Tampico, Tamaulipas, Mexico (Coll. J. O. Snyder, No. 6,165, L. Stanford, Jr. Univ. Mus.).

Color in alcohol of adult male. Deep olivaceous above, and becoming paler where it extends down along the middle of the side. Posteriorly the dark upper color extends lower. Each scale on the upper surface margined with darker, and the side of the body sprinkled with diffuse dusky specks. Chin and jaws dusky. Lower surface of the head cadmium-yellow, burnished with brassy-orange, and then becoming whitish below. Cheek and lower opercle marked with diffuse dusky specks. Abdomen and lower half of the body pale orange, becoming whitish below, and grayish posteriorly. Five or six longitudinal rows of bright orange spots running along the side, the uppermost following the lateral line, and the others parallel. Dorsal with its basal half dark, the rays deep gray, and the membranes black. Outer portion of the dorsal broadly bright orange. Caudal dark for two-thirds its basal portion, the median basal scales more or less silvery-gray, and then a broad black transverse median band formed by the black membranes, the rays grayish. Outer portion of the caudal broadly deep orange. Pectoral very dilute brown, the base obscurely orange, and then a pale slaty blotch. Ventrals and anal dilute orange. Iris deep brown.

Considerable variation occurs, many examples having as many as



CRAWLEY ON GREGARINES.



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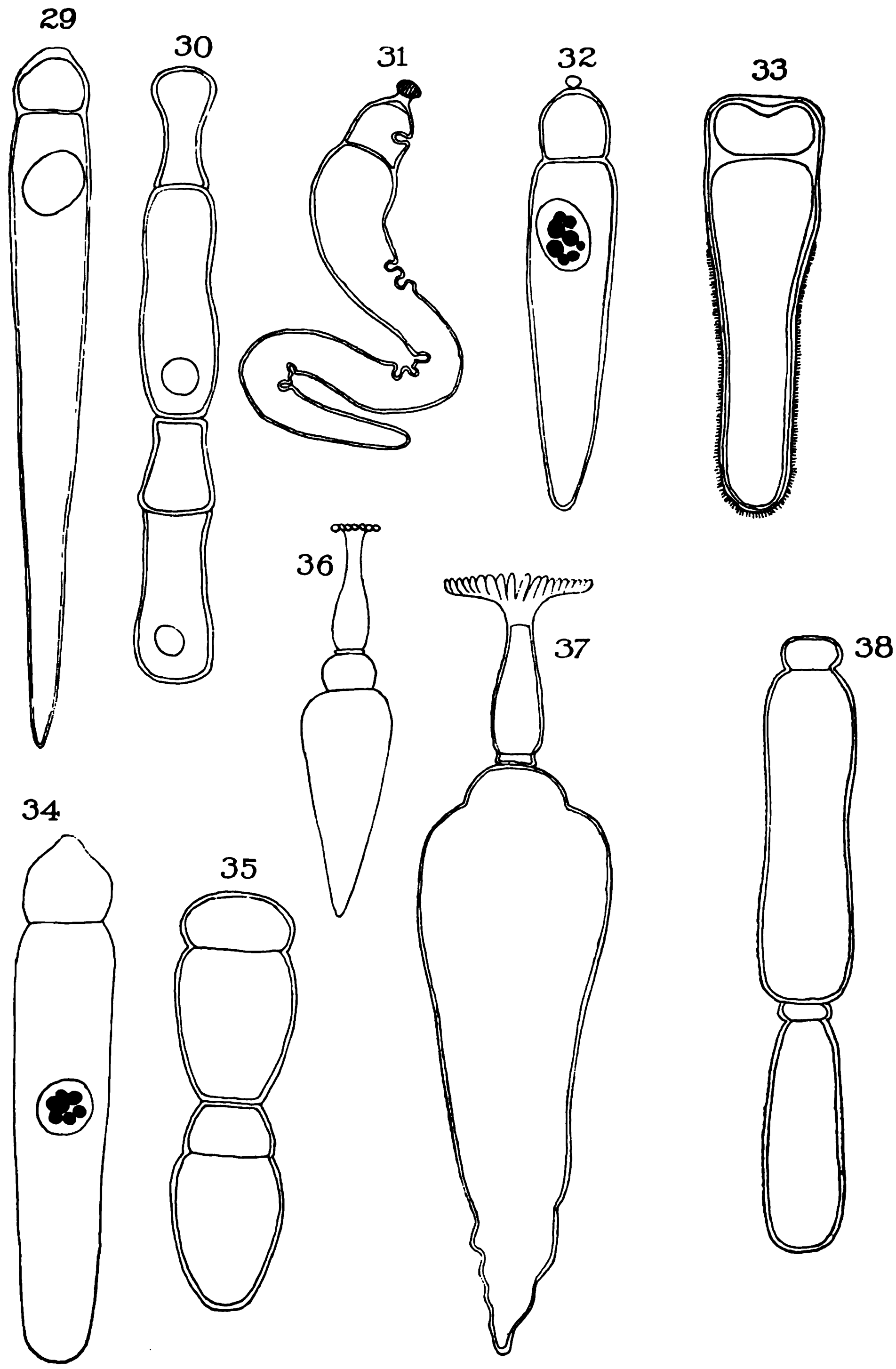

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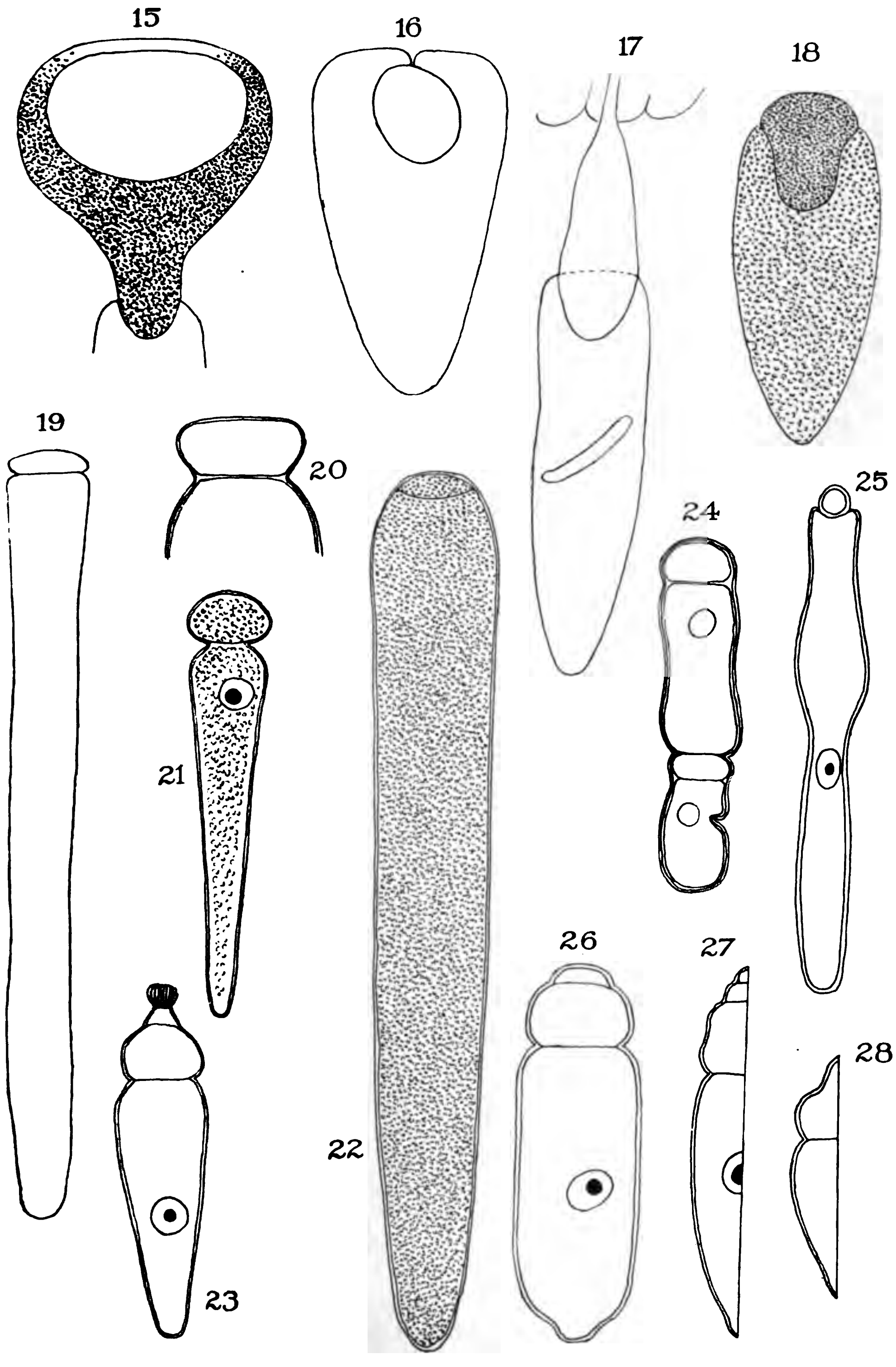

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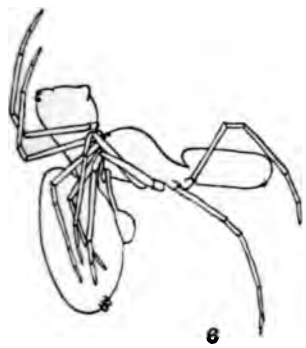

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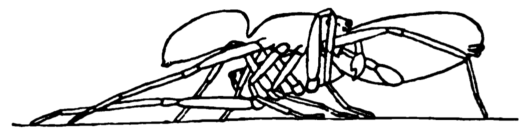

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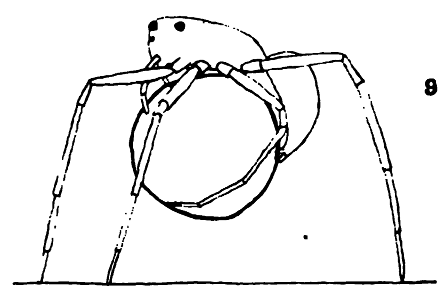

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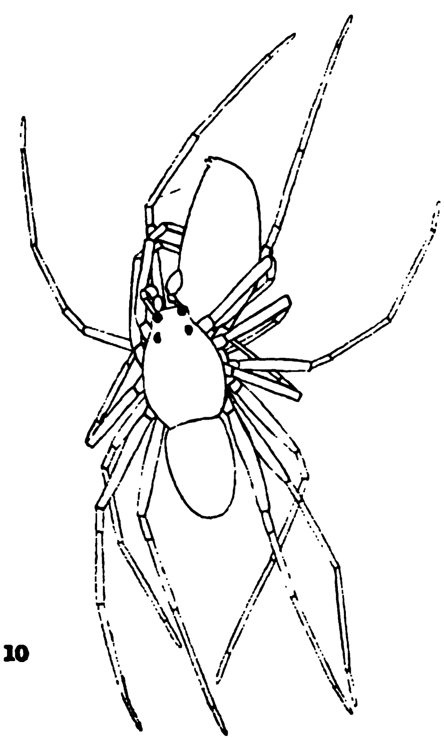

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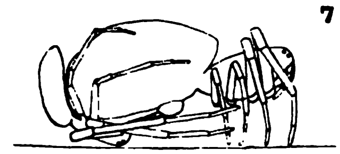

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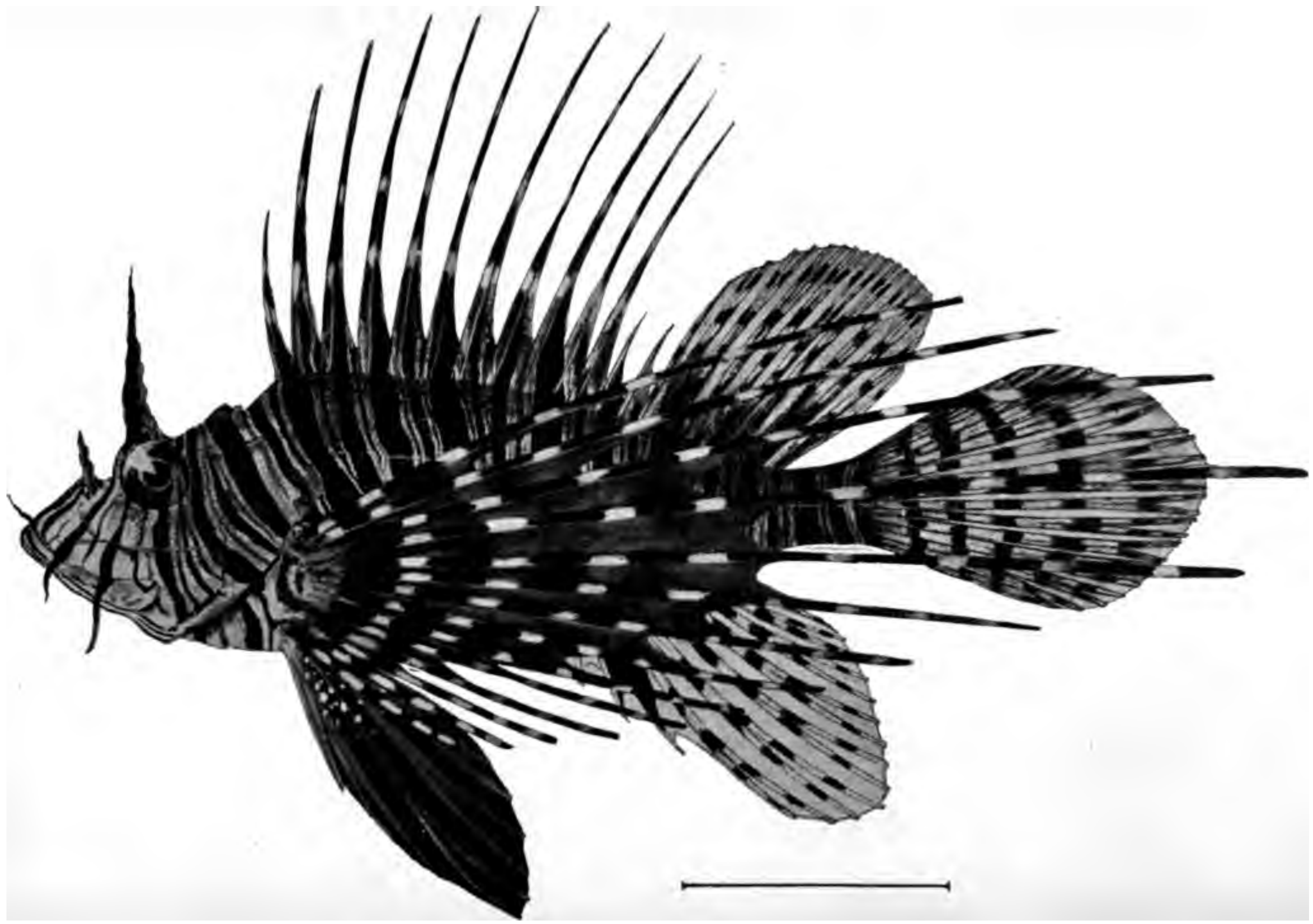
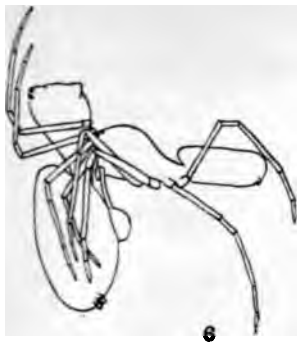
MONTGOMERY ON HABITS OF SPIDERS.



PTEROIS LUNULATA SCHL.



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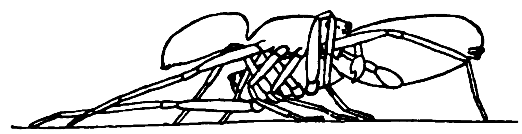

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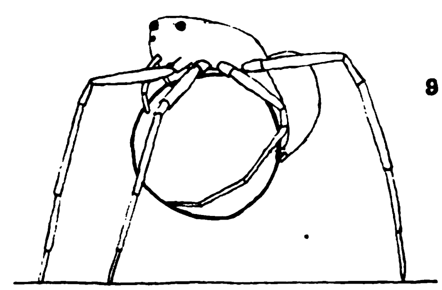

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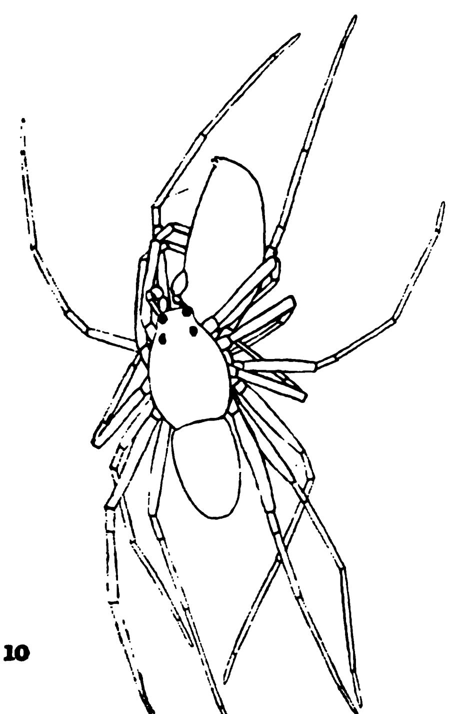

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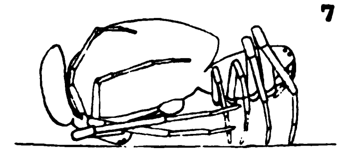

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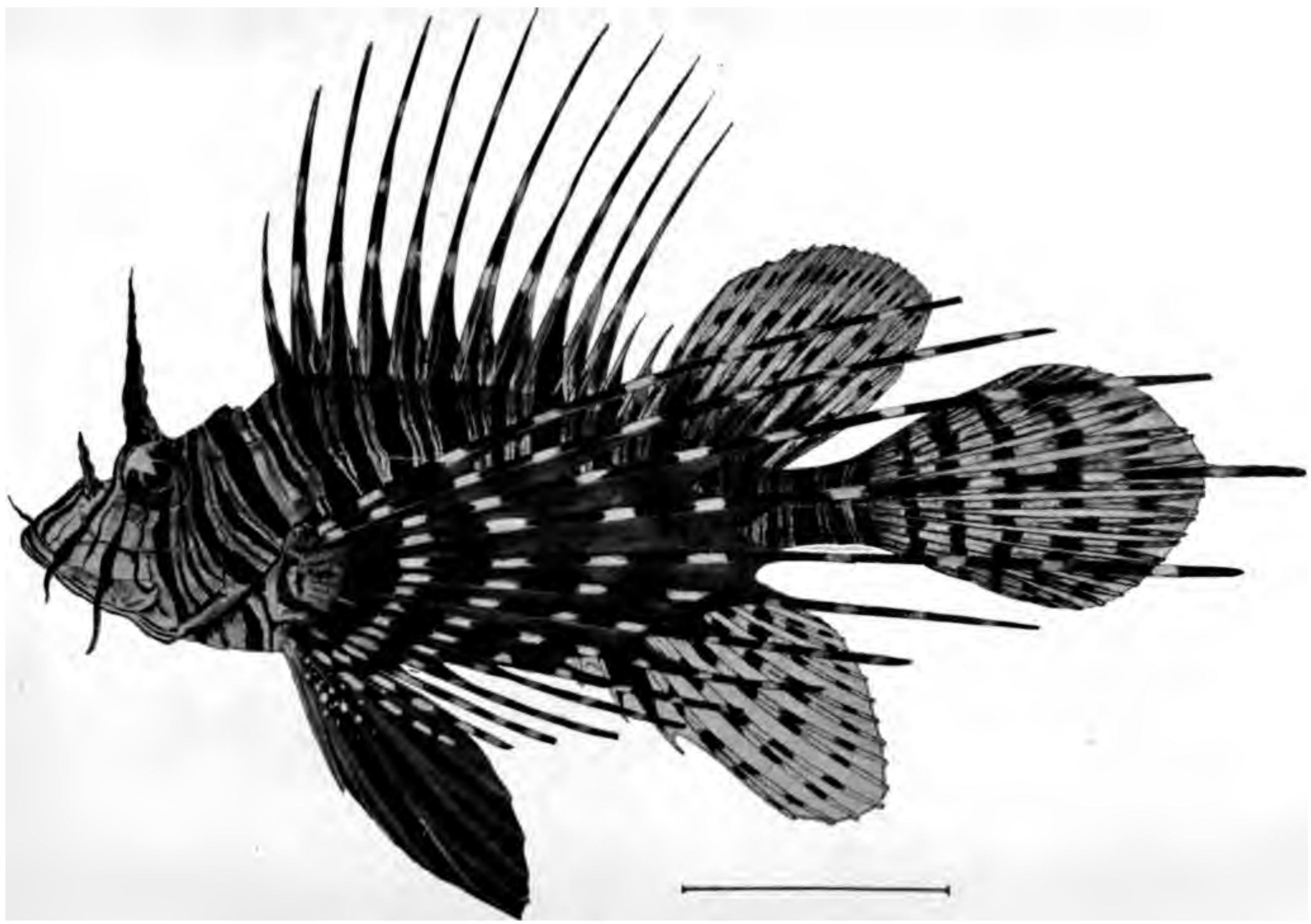
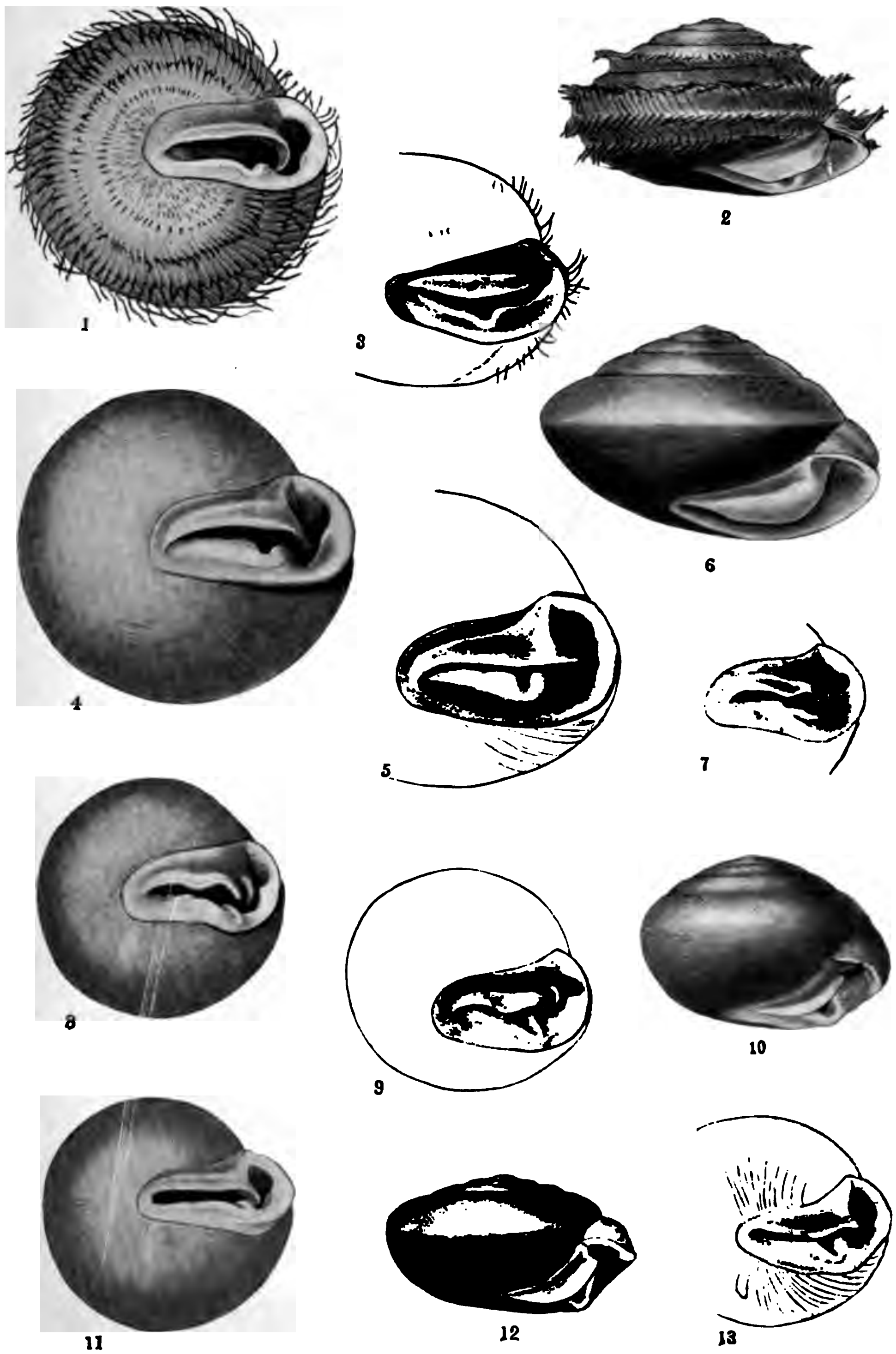
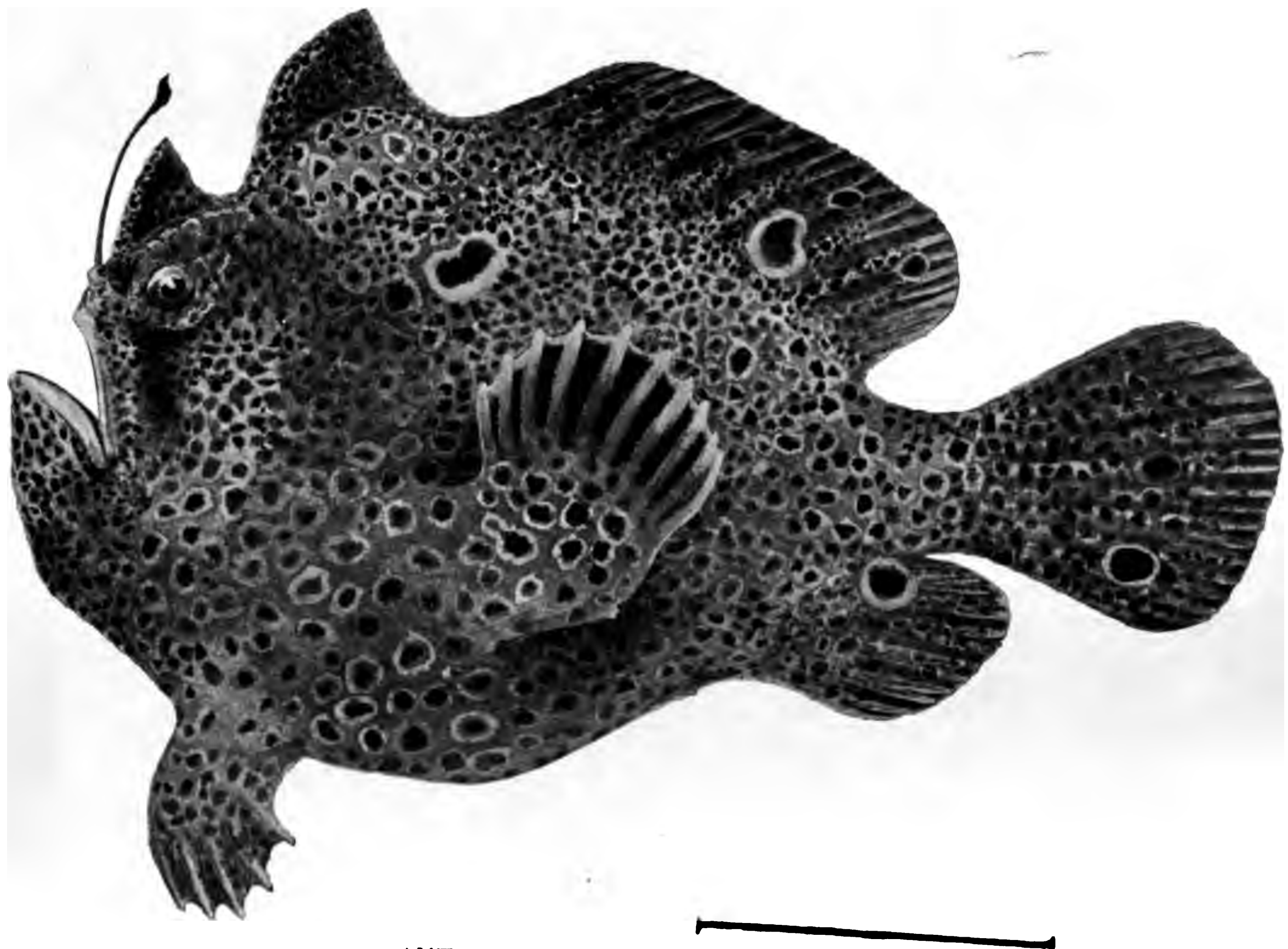
MONTGOMERY ON HABITS OF SPIDERS.

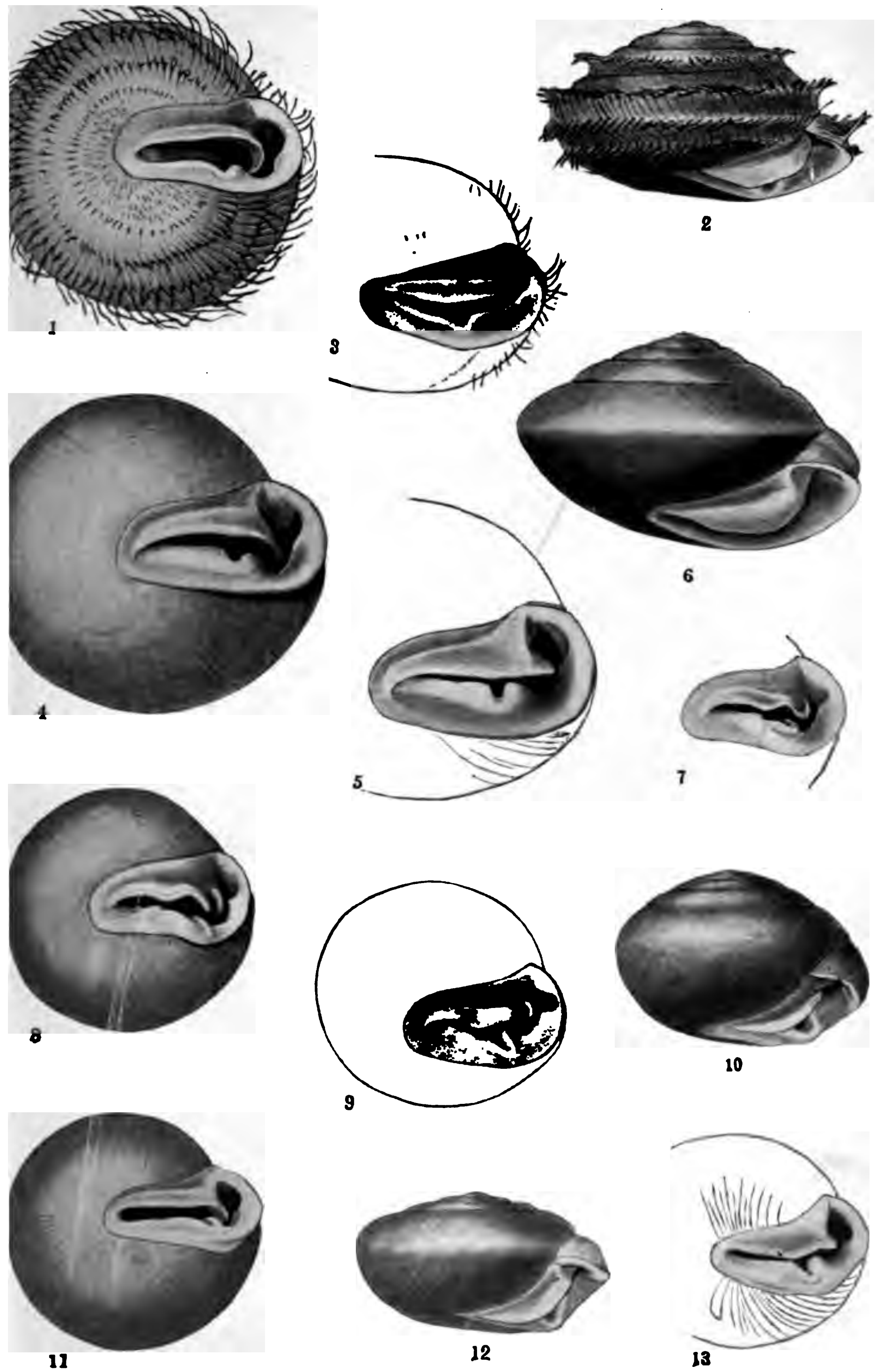




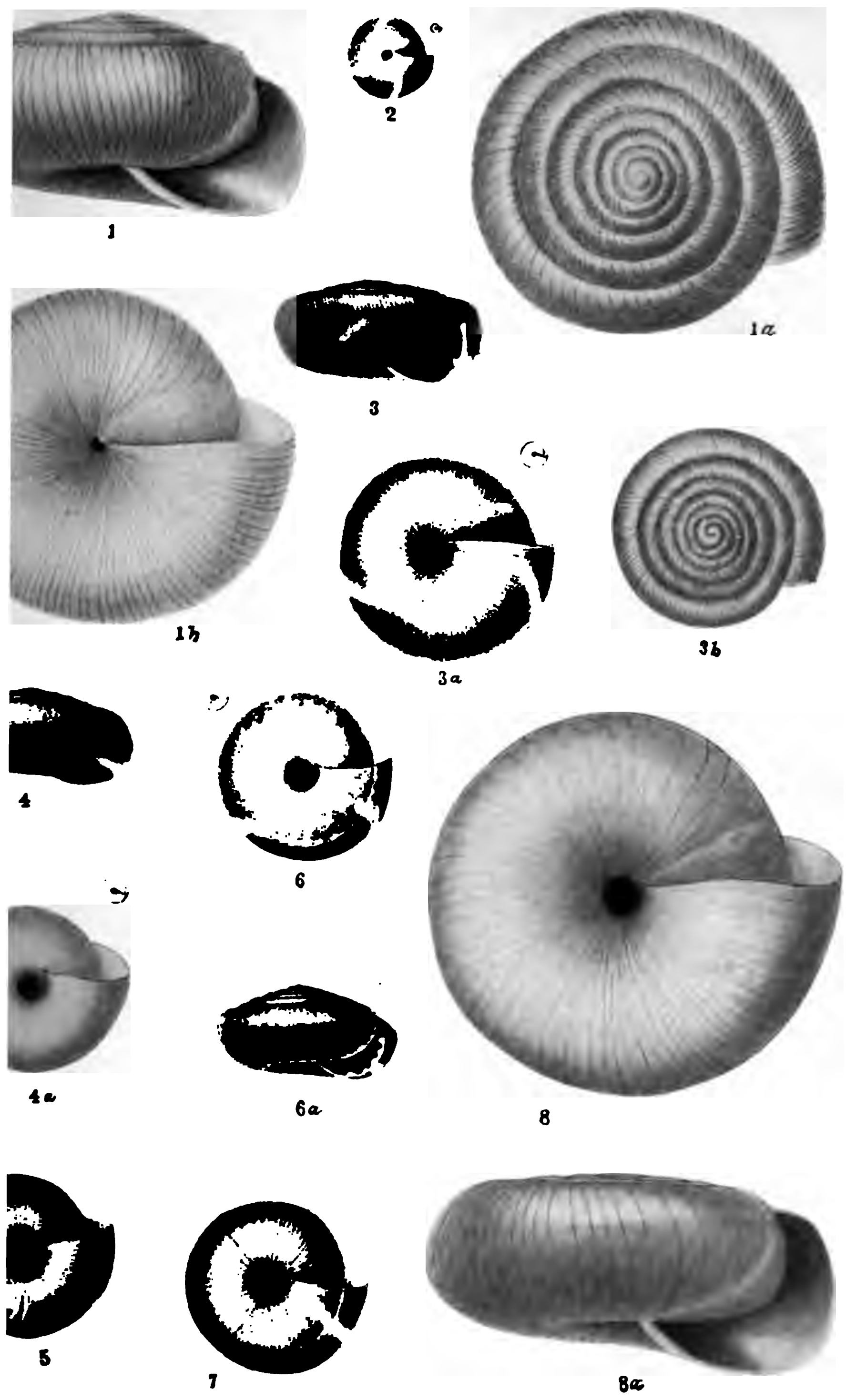
PILSBRY. MOLLUSCA OF WESTERN ARKANSAS, ETC.



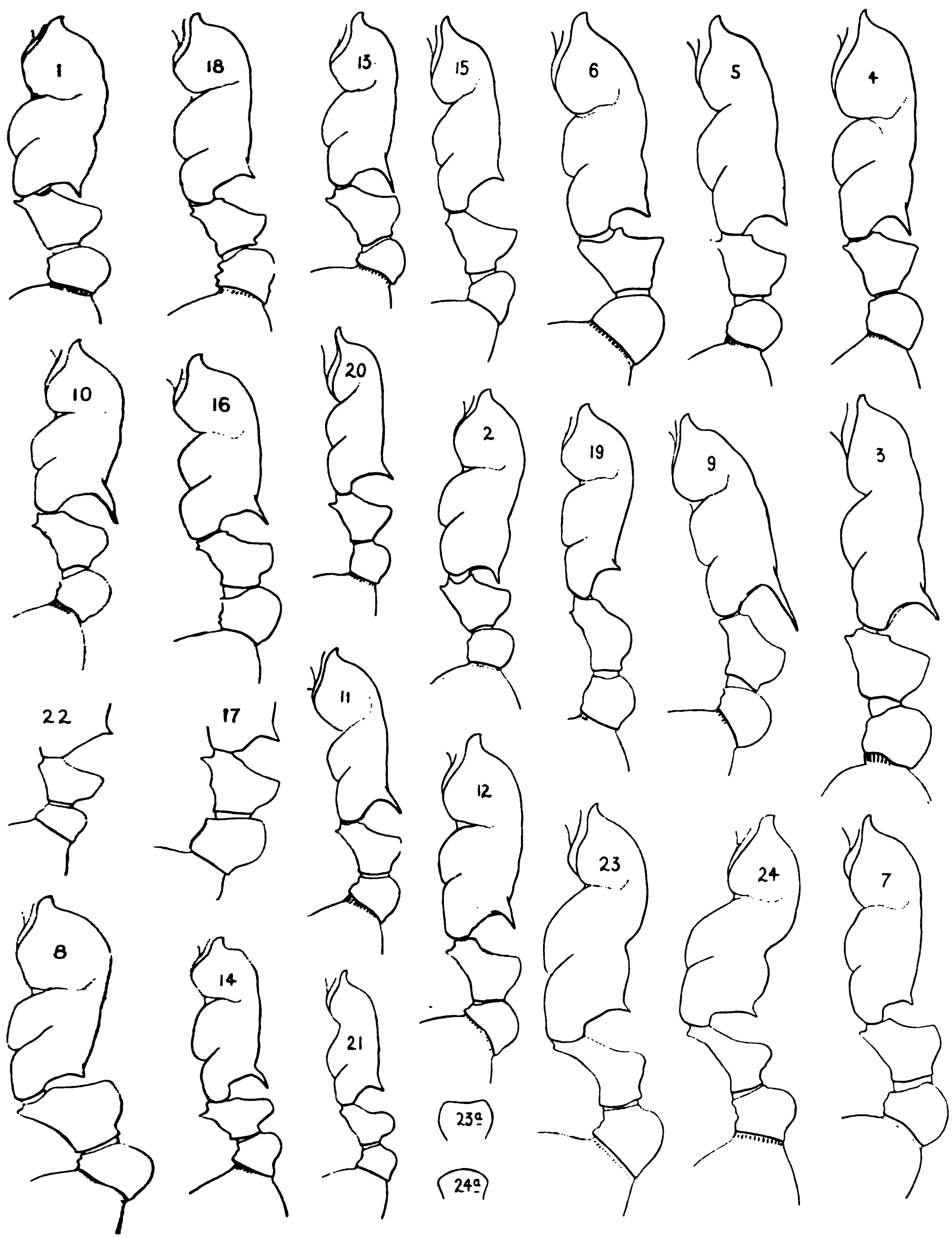
ANTENNARIUS ARGUS FOWLER.



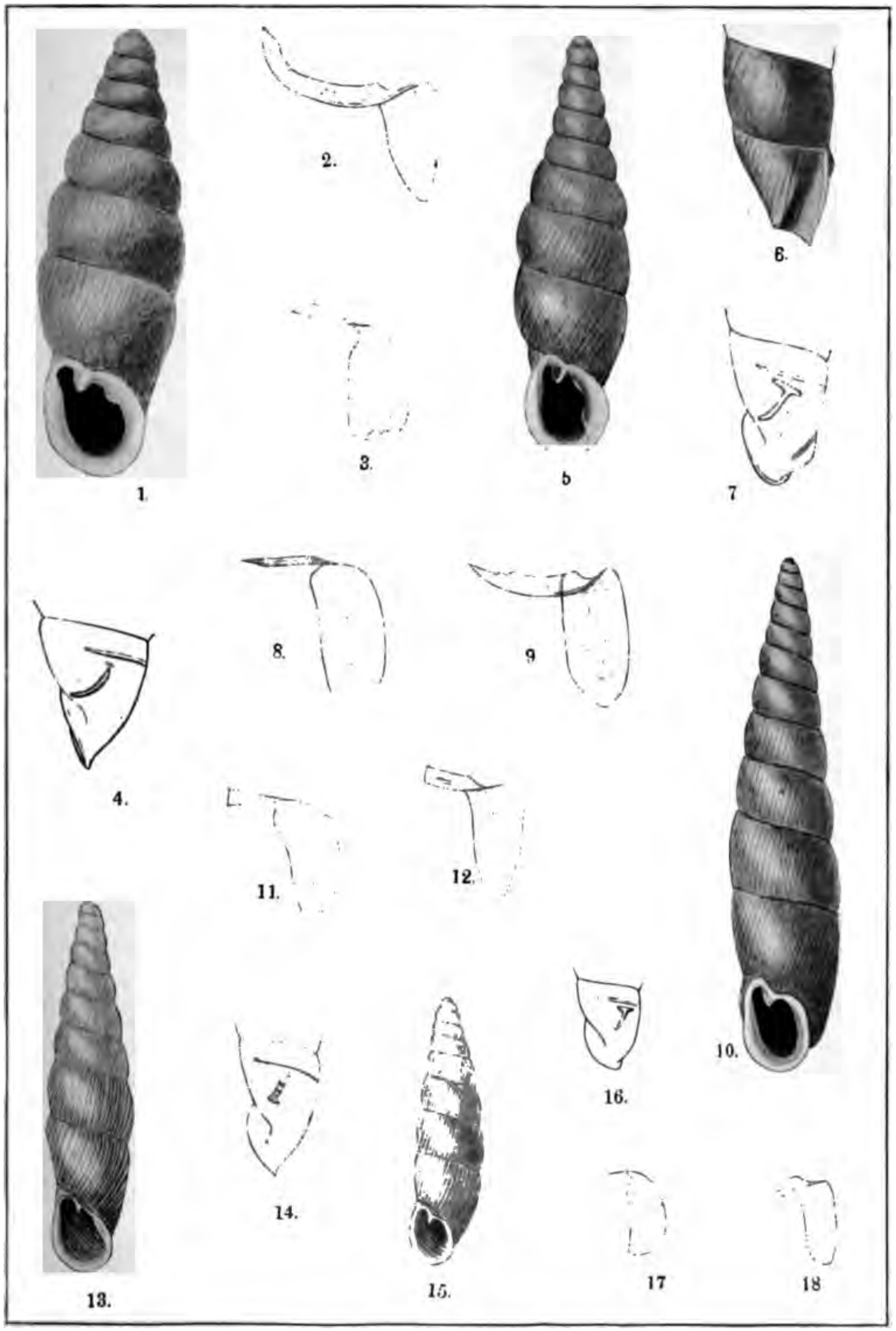
PILSBRY. MOLLUSCA OF WESTERN ARKANSAS, ETC.



PILSBRY. MOLLUSCA OF WESTERN ARKANSAS, ETC.



WHEELER ON LEPTOTHORAX.



PILSBRY. JAPANESE LAND SNAIL FAUNA.

dozen distinct vertical dusky-brown bars on the side of the back. Other examples show a blackish axillary blotch or several rather large dusky blotches either at the base of the caudal, on the back, or on the abdomen. Some examples are almost black above, and with intense orange on the fins. Nineteen examples.

Adult female. Olivaceous above, and extending over the greater part of the side, each scale margined with darker. About six distinct longitudinal series of dusky dots along the side, parallel with the lateral line. Lower surface of the body pale brown or brownish-white, somewhat silvery on the chest. Just above the anal many pale diffuse dusky specks. Dorsal, caudal and pectoral dilute brown, a little deeper basally. Anal with a pale orange tinge. Ventrals whitish. Many have the anal rather bright orange, and dark olivaceous blotches distributed with the same variations as seen with the dark blotches of the males. One female has the three series of dots running parallel to and below the lateral line, orange-ochraceous. Thirty-six examples mostly gravid with ova.

A large number of both young males and females show the coloration of the adult female, except the distinct series of dots along the side. The lower surface is almost entirely pale and uniform. Anal pale like the ventrals. The variation of dusky blotches is found in most of the examples, even the smallest.

This species has been taken also in the Rio Ixtla, at Puente de Ixtla,[1] Morelos, Balsas and La Antigua.[2]

CICHLIDÆ.

2. *Heros teporatus* sp. nov.

Head $2\frac{3}{5}$; depth $2\frac{1}{2}$; D. XV, 10; A. V, 8; P. I, 14; V. I, 5; scales 29 in a lateral series to the base of the caudal, about 17 in the upper part of the lateral line; 5 scales between the front of the dorsal and the lateral line, and 12 between the latter and the origin of the spinous anal; width of head 2 in its length; depth of head $1\frac{1}{6}$; snout $3\frac{1}{4}$; eye $3\frac{1}{8}$; interorbital space $3\frac{1}{2}$; fourth dorsal spine $2\frac{2}{3}$; least depth of caudal peduncle $2\frac{1}{2}$; anal $1\frac{1}{4}$; fifth anal spine $2\frac{1}{10}$.

Body elongate, compressed, the greatest depth about the origin of the spinous dorsal, and the back not conspicuously elevated. Upper profile evenly convex, though a little more curved than the lower. Caudal peduncle deep, compressed, and its length about two-thirds its depth.

Head rather triangular, compressed, and its depth at the posterior

[1] JORDAN AND SNYDER, *Bull. U. S. Fish Comm.*, 1900, p. 130.
[2] MEEK, *Field Col. Mus. Pub.*, 65, Zool., Ser. III, No. 6, 1902, p. 106.

margin of the gill-opening about equal to its length. Both profiles are slightly convex. Snout conic and rather short. Eye small, well anterior, and high. Mouth small, horizontal, and the jaws about equal. Maxillary small, and not reaching opposite the front rim of the orbit. Lips rather fleshy, and the lower forming a free fold across the mandible. Teeth uniserial, conic, and with a patch of villiform ones directly behind. Nostrils well separated, high, and the anterior midway between the tip of the snout and the front of the orbit. Interorbital space convex. Preorbital a little over half the width of the eye.

Gill-opening carried forward below the anterior rim of the orbit.

Scales rather large, finely ctenoid, and of about even size. Head scaly, except the snout and interorbital space, and about five rows on the cheek. Small scales along the bases of the fins, those along the spinous dorsal forming a low sheath. Lateral line high at first, interrupted below the posterior portion of the dorsal, then beginning on the middle of the side and running over eleven scales in a straight line to the base of the caudal.

Fourth to seventh spines of dorsal even and highest. Longest dorsal rays a little longer than the longest spines. Last anal spines longest, and a little shorter than the longest anal rays. Caudal truncate, with rounded corners. Pectoral rather long, reaching opposite the origin of the spinous anal. Ventral inserted a little behind the origin of the pectoral and reaching almost to the origin of the spinous anal.

Color in alcohol more or less olivaceous-brown, with about nine broad darker vertical bands fading out below. The one at the end of the pectoral with a black blotch, and another black blotch at the base of the median caudal rays. Fins dull olivaceous-dusky, the ventrals somewhat paler. Lower surface of the body pale.

Length $1\frac{5}{8}$ inches.

Type No. 24,242, A. N. S. P. Victoria, on the Victoria river, a tributary of the Rio Soto la Marina, Tamaulipas, Mexico. Coll. S. N. Rhoads.

One example. This species is very close to *Heros pavonaceus* Garman,[3] differing in the fin radii, the fewer vertical bands and only having two black blotches on the sides. The first of these is placed at the end of the pectoral just below the lateral line, and the other at the middle of the base of the caudal. In *Heros pavonaceus* they are more

[3] *Bull. Mus. Comp. Zool.*, VIII, p. 93; from a spring near Monclova (Coll. Dr. Palmer).

or less ocellated and vertically expanded, while in *H. teporatus* they are rounded black spots.

(***Teporatus***, made somewhat warm; on account of the warm springs flowing into the Victoria river where this species was taken.)

April 7.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Eight persons present.

Papers under the following titles were presented for publication:

"Certain Mounds of the Central Florida West Coast," by Clarence B. Moore.

"Certain Mounds of the Apalachicola River," by Clarence B. Moore.

April 14.

The President, Samuel G. Dixon, M.D., in the Chair.

One hundred and thirty persons present.

A paper entitled "A new Gurnard from Florida, with Notes on the Colors of some other Florida Fishes," by Henry W. Fowler, was presented for publication.

The death of J. Victor Carus, a correspondent, was announced.

Mr. Howard W. Dubois made a communication, illustrated by lantern slides, on a reconnaissance of the Rockies of British Columbia while prospecting for the platinum metals. (No abstract.)

April 21.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Eight persons present.

A paper entitled "Nosema geophile, sp. n., a Myxosporidian Parasite of Geophilus," by Howard Crawley, was presented for publication.

APRIL 28.

MR. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Eighteen persons present.

A paper entitled "A List of Arachnida from Hayti, with Descriptions of New Species," by Nathan Banks, was presented for publication.

The death of Theodore D. Rand, a member, April 24, was announced.

John V. Shoemaker, M.D., was elected a member.

The following were ordered to be printed:

THE MUTATION OF HIBISCUS MOSCHEUTOS L.

BY JOHN W. HARSHBERGER.

The views of De Vries on the origin of species by mutation rest upon the result of seventeen years of experimentation. This botanist holds that new elementary species arise suddenly without transition or intermediate forms, and that these species are constant from the moment of their origin and show no resemblance in their characters to the individual variations exhibited by the parent type. De Vries believes that mutability occurs only at certain periods, and a species might continue in existence indefinitely without giving rise to new forms. This succinctly states the position of the illustrious Dutch botanist upon the origin of species.

The observations here recorded are given with the hope that they may add somewhat to the discussion of the problems opened up by the work of De Vries.

Hibiscus moscheutos L., the swamp rose mallow, is found abundantly at Sea Side Park, N. J., where it covers acres of the salt marshes. Here, undisturbed by man, the plants offer special advantages for study. It was noticed that no two plants growing in the open meadow were exactly alike. Consequently, a study was instituted to determine, if possible, the character of the divergences. All of the plants studied grew practically under the same conditions, although in certain places the soil of the meadow was wetter than in others. So as to make the observations continuous for a number of years and upon the same plants, stakes were driven into the marsh at the base of each plant collected and studied. These stakes were marked by cutting Roman numerals into a planed-off portion at the top.

The plants numbered I–XII grew in a wet portion of the meadow near an open slue. Those designated as XIII to XXV grew in the drier portions of the meadow, excepting XXV, which grew beside a hole filled throughout the season with water. Specimens of these plants were submitted to Prof. De Vries, who pronounced upon them as follows, extracted from a letter dated November 26, 1902: "I have studied the *Hibiscus moscheutos* with the greatest interest, and believe, with you, that you have hit at cases of mutation parallel to that of

Œnothera Lamarckiana." The writer at least hopes that more detailed observations will confirm the encouraging words of Prof. De Vries. However, to know whether the mutability is still working, or whether the period has already come to a close, it is of course necessary to make sowing experiments. This was done last fall at Sea Side Park, where seeds obtained from capsules that had matured were marked by stakes and sown in a portion of the meadow destitute of the rose mallow to determine among the different forms which is the original and mutating one, because it is probable that the others would no more mutate or do so only in a restricted manner. Seeds of the several marked plants were also kept for future sowing.

All of the plants studied, with the exception of plants III, IV, V, XII, XVII, were more than of one year's duration. As is well known, *Hibiscus moscheutos* L. is perennial and persists for a number of years. The doubt might arise in the minds of some botanists that the smaller plants are small because they are juveniles and have not reached full maturity. The size of plants III, IV, V, XII, XVII and the shape of their leaves may be accounted for in this way, but the color of the flowers, leaves and markings can hardly be explained by a reference to the juvenile state, because these plants diverge as widely in appearance as the other twenty adult plants do from each other. The adult plants differ from each other, as do the plants of one year's growth, and the inference is, therefore, that the difference in size, mode of branching, size of leaves, shapes and colors of leaves, character of inflorescences, size and color of the flowers is not dependent upon whether the plant is juvenile or adult, but is due rather to the mutations that they have undergone.

Dried plants do not show the peculiarities of structure in as striking a manner as do living plants. In drying, the plants have lost form, and the color of the flowers and leaves has faded out. As the botanist, however, stands in the salt meadow where *Hibiscus moscheutos* L. abounds and runs his eye over the thousands of plants that are found there, he cannot fail but notice the various striking forms characterized by habit of growth, size and color of the stem, leaves and flowers, that have been produced, as the writer believes, by the process of mutation. One plant is tall and has pure white flowers with bronzed leaves. Another is bright green with rose-pink flowers, while still another plant is corymbosely branched and has deep rose-red flowers. These peculiarities are mentioned as they occur in twenty-five plants gathered in the summer of 1902 for comparative study.

DESCRIPTION OF A NEW GURNARD FROM FLORIDA, WITH NOTES ON THE COLORS OF SOME OTHER FLORIDA FISHES.

BY HENRY W. FOWLER.

A small collection of fishes has recently been received at the Academy from Dade county, Fla., in the Biscayne Bay region. It was made during February of the past winter. The Academy is indebted to Mr. James Spear, Jr., for this addition to its collections. He was also fortunate in being able to forward the specimens in a nearly fresh state of preservation, so that I can give most of the life colors.

CARANGIDÆ.

1. Selene vomer (Linnæus).

1758. [*Zeus*] *Vomer* Linnæus, Syst. Nat., Ed. X, I, p. 266; in America.

Color in alcohol with brilliant silvery prevailing, and everywhere with beautiful purplish and bluish reflections. Back and upper surface of the caudal peduncle purplish-brown, deepest along the dorsal profile. A large scattered tract of dusky dots, becoming darker and most distinct immediately above the eye. Axil of the pectoral pale yellowish with dusky dots. Spinous dorsal dusky. Soft dorsal whitish, with the long anterior rays dusky, the longest ray very dark. All the other fins whitish with more or less dusky on their outer portions. Upper and lower anterior margins of caudal lobes dusky.

One example 10 inches in length, from New river.

NOMEIDÆ.

2. Nomeus gronovii (Gmelin).

1788. [*Gobius*] *Gronovii* Gmelin, Syst. Nat., I, p. 1,205; in oceano americano zonae torridae.

Color in alcohol dark brown on the back and top of the head, the sides and lower surface silvery-white. The dark brown of the back extends down on the sides in the form of five large saddle-like blotches becoming grayish below. Lower side of the body with six or seven grayish-brown blotches. Lower surface of the head with several grayish blotches. Fins slightly tinged with straw-color, which may be due to the preservative. Spinous dorsal black. Soft dorsal with three broad transverse blackish vertical bands, leaving only narrow pale spaces between. Anal with three narrow transverse blackish

vertical bands, which extend a little on the lower surface of the body, and leave broad spaces between. Two small blackish spots on the lower edge of the caudal peduncle. Caudal with a blackish blotch at the base of each lobe. Median portion of each caudal lobe blackish. Pectoral with a longitudinal median blackish streak, becoming diffuse on the outer portion. Membranes of the ventral black, except the outer portion, which is pale straw-color, like most of the rays.

Length 4¾ inches.

One example taken from below a Portuguese man-of-war (*Physalia*) in Biscayne Bay.

SERRANIDÆ.

3. Diplectrum formosum (Linnæus).

1766. [*Perca*] *formosa* Linnæus, Syst. Nat., Ed. XII, p. 488; Carolina (Coll. D. Garden).

Color in alcohol pale brown above, the lower surface silvery-white. Back and upper side with eight broad transverse deep brown bands, with alternating deep brown narrow bands between. A deep brown band from the tip of the snout to the base of the upper caudal lobe. Above this two similar narrow dusky-brown bars. Where all these bars cross dark areas are formed. The side of the head and trunk are also marked with narrow pale slaty longitudinal lines, each one with a little darker margin. Dorsals and caudal with dilute yellowish-brown, the former marked on the spinous portion with two broad pale slaty longitudinal bands which run back on the soft fin higher and lower, the intervening space marked with another similar parallel band. All of these bands are darker along their edges, and run higher on the posterior soft dorsal, where a fourth runs backward from the base of the sixth ray. Caudal with six more or less connected lines or bands, especially above, so that the fin has a spotted appearance. Anal pale yellowish-white, with many dilute slaty lines. Pectoral and ventral whitish. A dusky spot on the chin. Interorbital space with two narrow connecting lines, also one between the nostrils.

Length 8 inches.

One example from lower Biscayne Bay.

LUTIANIDÆ.

4. Neomænis apodus (Forster).

1792. *Perca apoda* Forster, in Walbaum, Pet. Arted. Gen. Pisc., III, p. 351 (Based on *Perca marina pinnis*, etc., Catesby, Nat. Hist. Car. Flor. Bah. II, 1731, p. 4, Pl. 4, lower figure; no locality.)[1]

Color in alcohol more or less faded dull uniform olive, pale below.

[1] Credited by Pennant (*Arctic Zoology*, II, 1792, p. 385) to the Bahama isles.

Pale vertical streaks or lines obscure. A slaty line below the eye to the end of the opercle, and another below this. A brown streak across the base of the pectoral.

Two young examples from Card Sound.

5. **Ocyurus chrysurus** (Bloch).

1797. *Sparus chrysourus* Bloch, Ichthyologie, III, Pt. 8, p. 25; les eaux du Brésil.

Sparus Chrysurus Bloch, *l. c.*, Plate 262.

Color in alcohol with upper surface deep olivaceous-gray, and the sides and lower surface rosy. A bright greenish-yellow band from the tip of the snout, at first narrow, and then widening posteriorly until it includes the entire caudal fin. Above this, back, and on the upper surface of the head, are a number of dark greenish-yellow spots. Each scale on the cheek, and lower surface of the head, with a deep rosy spot. Above the lateral line oblique dusky lines with a rosy tinge running up to the base of the dorsal. Between the arch of the lateral line, and the golden lateral band, are about four narrow, deep rosy lines running parallel. Just below the yellow band are also two parallel deep rosy lines leaving a paler rosy space between, then the rest of the lower surface is marked with seven or eight longitudinal bright greenish-yellow narrow bands alternating with similar ones of deep rosy. The lower edge of the abdomen, and under surface of the head, is whitish. The scales on the chest and lower part of the abdomen are more or less whitish basally, producing an imbricated appearance. The top of the head is marked with bright olivaceous spots. Dorsals and anal olivaceous-yellow, the soft dorsal becoming very bright posteriorly. Pectorals and ventrals yellowish-white. Iris red. Lips dusky. Inside of the mouth and gill-opening whitish.

One example 7 inches long, from lower Biscayne Bay. Comparison with Brazilian examples is desirable.

HÆMULIDÆ.

6. **Hæmulon sciurus** (Shaw).

1803. *Sparus Sciurus* Shaw, Gen. Zool., IV, p. 439, Pl. 64; American seas.

Color in alcohol olivaceous-dusky above, paler on the sides, and becoming yellow below. Everywhere more or less brassy. Side with about ten longitudinal slaty-blue stripes, each one edged narrowly with deep slaty. Spinous dorsal dilute grayish-green. Soft dorsal dusky. Caudal dusky, the outer portion dilute greenish-yellow. Anal bright yellowish-green with the base dusky. Pectoral grayish. Ventral bright yellowish-green. Each ramus inside the mouth bright brick-red. Inside of the gill-opening reddish above. Peritoneum black.

One example 9½ inches long, from lower Biscayne Bay.

7. Hæmulon plumierii (Lacépède).

1800. *Labrus Plumierii* Lacépède, Hist. Nat. Poiss., III, pp. 432, 480, Plate 2, fig. 2; Amerique.

Color in alcohol brassy grayish-brown, darker on the upper surface. Side with many light blue lines, each one bordered with deep slaty, mostly longitudinal, and those running from the pectoral and ventral very oblique. Fins dusky, and the margins of the membranes of the spinous dorsal narrowly deep brown. Base of ventral dilute greenish. Inside of the base of pectoral yellowish with bluish lines. A brown bar across base of the pectoral. Inside of the mouth, and lower lip posteriorly, orange-red. Outer portion of first ventral ray whitish.

One example 7½ inches long, from lower Biscayne Bay.

SPARIDÆ.

8. Calamus bajonado (Schneider).

1801. [*Sparus*] *Bajonado* Schneider, Syst. Ichth., p. 284. (Based on *Bajonado* Parra, Descr. Piez. Hist. Nat., 1787, p. 13, Pl. 8, fig. 1; Cuba.)

Color in alcohol brassy-brown, the margin of each scale with a narrow darker submarginal border. Back a little deeper than the lower surface, which is washed with silvery. A dull bluish line below the eye running forward toward the tip of the snout. Below this an indistinct bluish line, and also several bluish spots on the cheek. A bluish line across the upper edge of the opercle. Two narrow bluish lines running out from the front of the eye. A dusky band from the lower rim of the orbit to the corner of the mouth, and across the mandible. Vertical fins, and ventral, dull slaty mottled with brownish. Pectoral pale brownish-white. Axil of pectoral pale yellowish. Peritoneum silvery. Iris flesh-colored, upper anterior portion dusky.

One example 7½ inches long, from lower Biscayne Bay.

9. Lagodon rhomboides (Linnæus).

1766. [*Sparus*] *rhomboides* Linnæus, Syst. Nat., Ed. XII, I, p. 470; in America (Coll. D. Garden).

Color in alcohol dusky-olivaceous on the back, merging into silvery-white on the lower surface. About seven vertical dusky cross-bands, with as many narrower and indistinct ones between. A deep brown blotch on the lateral line above the base of the pectoral. Side with eleven longitudinal slaty-blue bands, the intervening spaces more or less gilded. Fins, with the exception of the ventrals, pale dusky, the basal portions of the dorsals with many large gilded spots. Anal more or less pale golden. Ventral whitish with a large golden basal blotch. Iris clouded with dusky.

One example 4⅝ inches long, from New river, Fla.

GERRIDÆ.

10. Eucinostomus harengulus Goode and Bean.

1879. *Eucinostomus harengulus* Goode and Bean, Proc. U. S. Nat. Mus., p. 132; West Florida (Coll. MM. Kaiser and Martin).

Color in alcohol very pale olivaceous-brown above, more or less silvery, and the lower surface silvery-white. The back is also clouded with a deeper shade of the general body color. All of the scales with a more or less bright metallic bluish or purplish luster. Snout brownish. Upper portion of spinous dorsal blackish. Upper vertical fins slightly brownish, other fins whitish. Iris silvery, with dusky blotches.

One example $3\frac{1}{8}$ inches long, from New river.

11. Xystæma cinereum (Walbaum).

1792. *Mugil cinereus* Walbaum,[2] Pet. Art. Gen. Pisc., III, p. 228. (Based on *Turdus cinereus peltatus* Catesby, Nat. Hist. Car. Flor. Bah., II, 1731, p. 11, Pl. 11, lower figure; no locality.)[3]

Color in alcohol pale olivaceous-brown, the lower surface whitish. Body washed with silvery, showing purplish-blue reflections. Side with seven vertical dull purplish bands running down from the back. Vertical fins with minute dots of dusky, also on the ventrals. Spinous dorsal and ventrals washed with dilute greenish-yellow. Iris grayish-silvery. Peritoneum white.

One example $11\frac{3}{4}$ inches in length, from New river.

LABRIDÆ.

12. Iridio bivittatus (Bloch).

1797. *Labrus bivittatus* Bloch, Ichthyologie, III, Pt. 8, p. 107, Pl. 284, fig. 1; j'eu ignore la patrie.

Color in alcohol greenish-olivaceous, pale or whitish below, and the edge of each scale more or less tinted with dull coppery. A dull purplish band running from the upper part of the eye, narrowly bordered on each side, while on the head, with blue. It runs along the base of the dorsal. A dusky purplish band runs from the side of the snout through the eye to the base of the caudal above, and along the side of the trunk it is very broad. A similar narrow band from the pectoral along the lower side. A narrow pale dusky band starts above the opercle and includes the lateral line till it descends posteriorly.

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[2] I have recently rejected Walbaum's name *Raia birostris*, adopting *Raia manatia* of Schneider. A re-examination of Walbaum convinces me that the word *birostris* is evidently a typographical slip, and that such names as he used in the "Additamentum" are available as binomials, for in every case a specific name is italicised. The name *Mobulidæ* should supersede *Mantidæ*. See *Science*, XVII, April 10, 1903, p. 594.

[3] Pennant says (*Arctic Zoology*, II, 1792, p. 377), under his discussion of *Labrus hiatula* Linnæus, that it inhabits the seas of Carolina, "as I suppose the three former do," of which the one immediately preceding is Catesby's fish.

A pale purplish streak below the base of the pectoral. A purplish Y-shaped bar on the opercle, with narrow pale blue margin, and with a deep violet-blue spot above. Upper lip olive-green. Cheek pale. Mandible with two brownish-purple cross-bars narrowly bordered with pale bluish. Dorsal fins dilute orange, basally dusky, with greenish spots narrowly margined with pale bluish. Anal similar, grayish, and with dull rosy tints. Caudal deep orange-red, marginal portion of the fin blackish, and with pale oblique bluish stripes. Axil of pectoral pale green. Iris bright orange edged with green.

One example 8¾ inches long, from lower Biscayne Bay. I am not certain that my fish is identical with Bloch's account, as it also does not agree with his figure. Lacépède's account is less satisfactory.

TETRAODONTIDÆ.

13. Cheilichthys testudineus (Linnæus).[4]

1758. [*Tetraodon*] *testudineus* Linnæus, Syst. Nat., Ed. X, p. 332; in India.[5]

Color in alcohol dark slaty-brown, the sides gradually becoming whitish below with a dull ochraceous tinge, especially along the lower side of the head. Large deep blotches of blackish-brown on the back, made up of clusters of crowded spots which leave winding paler lines between. On the sides these spots become separated and are very distinct against the paler background. Axil of the pectoral brown. Fins dull dusky with an indistinct tinge of dilute olivaceous, except the anal which is white. Lower surface of the body chalky-white. Iris yellowish-gray.

One example 8¾ inches in length, lower Biscayne Bay.

TRIGLIDÆ.

Merulinus Jordan and Evermann.

Bull. U. S. Nat. Mus. (Fish. N. Mid. Amer.), No. 47, II, 1898, p. 2, 148.

Type [*Trigla*] *carolina*[6] Linnæus, Mantissa Plant., 1771, p. 528; in Carolinæ mari (Coll. D. Garden).

14. Merulinus salmonicolor sp. nov.

Head 3; depth 4¾; D. X–I, 11; A. II, 9; P. III, 12; V. I, 5; scales

[4] *Cheilichthys* is given generic rank for those American forms with a broad, flattened, or only slightly concave interorbital space. Type *Tetraodon testudineus* Linnæus.

[5] The type of the species probably came from tropical America. The rude accounts of Clusius and Willughby throw little light on the subject. I have been unable to consult Dr. Gunther's reference, "*Tetrodon testudineus*, L. Amœn. Acad., i, p. 309, tab. 14, fig. 3." The edition of Amœnitates Academicæ, etc., in the Academy's library, has an account of *Ostracion oblongus glaber*, etc., by Balk (1749, p. 591). It is based on Artedi, Willughby, Clusius, Ray and Sloan, and no locality is given. If, however, Linnæus should be found untenable, *Tetrodon geometricus* Schneider is the next name available with certainty.

[6] This name is transposed from the original.

95 in the lateral line to the base of the caudal, and about 6 more on the base of the caudal; 10 scales between the origin of the soft dorsal and the lateral line in a vertical series, and about 24 between the latter and the origin of the anal; pores 50 in the lateral line to the base of the caudal; width of the head $1\frac{2}{5}$ in its length; depth of head $1\frac{7}{10}$; snout 2; eye $5\frac{2}{3}$; maxillary $2\frac{1}{2}$; mandible $2\frac{1}{6}$; width of mouth at corners $2\frac{2}{5}$; interorbital space $5\frac{1}{2}$; first dorsal spine $2\frac{5}{6}$; third $2\frac{1}{6}$; first dorsal ray $2\frac{1}{3}$; first anal ray $3\frac{1}{2}$; eighth anal ray $2\frac{15}{16}$; upper caudal lobe $1\frac{1}{3}$; least depth of caudal peduncle $4\frac{3}{7}$; ventral $1\frac{1}{9}$; space between bases of innermost ventral rays $3\frac{4}{7}$; ventral spine $2\frac{2}{3}$.

Body rather stout, cylindrical, short in comparison, and thickest anteriorly, so that the greatest depth falls opposite the fourth dorsal spine. The upper profile is evenly convex from above the eyes to the upper region of the caudal peduncle. Lower profile more or less straight. Chest and breast flattened, and broad. Caudal peduncle and posterior portion of the trunk compressed, so that the depth of the former, measured from the base of the last dorsal ray, is about one and four-fifths in its length. The upper and lower surfaces are also somewhat flattened.

Head moderately large, broad and high, and its lower profile horizontal. Snout long, broad, oblique, and the profile straight. The upper jaw projects down a little beyond the anterior profile of the snout, which, when viewed from above, is seen to be concave. On each side broad round processes with denticulated edges are developed, and project anteriorly. At the posterior outer edge of each is a small spine. Eye a little posterior in the head, and impinging on its upper profile. A furrow runs from the lower edge of the eye down along the front of the snout to the nostrils. Mouth large, the jaws moderate, and the lower inferior. Maxillary falling a little short of the front rim of the orbit, and its distal expanded extremity about two-thirds the orbit. Teeth minute, and in rather broad, rasp-like bands, in the jaws. Similar but smaller teeth in narrow bands on the vomer and palatines. Tongue large, broad, thick, smooth, and only the small tip free in front. Lateral articular region of the mandible with a short series of small serræ. Nostrils anterior, near together, the anterior with a little flap, and the posterior a little nearer the tip of the upper jaw than the eye. Interorbital space rather narrow, a trifle less than the internasal space, flattened in the middle, and each side a little elevated. Top of the head very slightly convex.

Bones of the head all with fine radiating striæ. Four preocular spines, the innermost the larger. Two postocular spines. Two tym-

panic spines, the posterior rather large. A small coronal spine. Nuchal spine long. Preopercular, opercular and humeral spines large and strong, and of more or less even size. Anterior and lateral labial bones each with a small spine, that of the latter minute.

Gill-opening extending forward nearly opposite the posterior nostril. Gill-rakers III 1+8 VI, compressed, short, their inner edges with minute asperities, and the longest a little shorter than the longest filaments, which are half the eye diameter. Pseudobranchiæ large. Isthmus very broad, flattened, and the gill-membrane free.

Peritoneum silvery.

Anus close to the origin of the anal fin.

Scales small, finely ciliated, and greatly reduced on the front of the back. Scales on the belly small and smooth. Base of the caudal scaly. Space between pectoral and ventral naked. Lateral line composed of simple tubes, high, continuous, mostly concurrent with the dorsal profile, and running down a little above the middle of the caudal peduncle.

Origin of the spinous dorsal directly after the base of the pectoral, the third spine the highest, the first longer than fifth, and the others all graduated down to the last, which is very short. The soft dorsal is inserted a little nearer the front of the eye than the base of the caudal, the anterior rays a little the highest, and like the spinous fin, depressable in a rather broad groove. Margin of the soft dorsal with small notches. Caudal long, truncate. Anal inserted below the origin of the soft dorsal, the spines flexible, shorter than the rays, and the second a little the longer. Margin of the rayed anal deeply notched, and the penultimate ray the longest. Pectoral long, reaching opposite the base of the last anal ray, and the eighth ray the longest. Ventral long, reaching the anal fin, and the third and fourth rays the longest and about equal.

Color in alcohol deep olivaceous-brown on the upper surface, indistinctly variegated with small darker specks. On the head these are more distinct and form short wavy lines. Edges of the mouth and gill-opening pale yellowish, the latter somewhat tinged with salmon. Lower surface of the body white, the flanks tinted with salmon-pink. Anal pink. Dorsals and caudal dusky, the former marked with diffuse darker spots. A dark spot in front of the third dorsal spine near its margin. Pectoral blackish, variegated with rather large black spots, and its inner ray whitish basally. Ventrals whitish, with many dusky dots. Iris grayish-brown. Inside of the gill-opening brassy-dusky and blackish.

Length 10 inches.

Type No. 24,343, A. N. S. P. New river, Dade county, Fla. Coll. Mr. James Spear.

One example. This species is related to *Merulinus carolinus*, *M. scitulus*, *M. roseus* and *M. alatus*. It is closer to the latter in squamation, but differs in more gill-rakers and shorter pectoral. The preopercular spine is also shorter. From the other species it is chiefly distinguished by its bright salmon-pink anal fin.

(*Salmo*, the salmon, *color*, color; referring to the anal fin.)

15. Prionotus evolans (Linnæus).

1766. [*Trigla*] *evolans* Linnæus, Syst. Nat., Ed. XII, p. 498; in Carolina.

Color in alcohol dull olivaceous-dusky above, the lower surface whitish. Back with three dark cross-bands, and indistinct darker mottlings. Head also mottled with darker, sometimes forming diffuse lines. A blackish bar across the interorbital space. Dorsals and caudal grayish-brown diffused with darker. Pectoral slaty-black with rather large round blackish spots and the edge of the inner ray whitish. Other fins white, the ventrals soiled a little on their median outer surface. Inside of the gill-opening dull yellow, reddish on the shoulder-girdle. Eye deep gray-brown.

One example 9$\frac{3}{8}$ inches long, from New river.

ECHENEIDIDÆ.

16. Echeneis alba-cauda Mitchill.

1817. *Echeneis alba-cauda* Mitchill, Amer. Month. Mag. Crit. Rev., II, p. 244; in the bay of New York, June 22, 1815.

Color in alcohol dull brown. A broad lateral blackish-brown band running from the mouth to the base of the caudal, and bordered narrowly below with dull slaty-white. Lower rays of the dorsal and anal dusky-brown, and this color extending forward on these fins for the same height, but becoming a little pale. The remaining outer portions of the anterior rays and edges, narrowly, of the others, whitish. Caudal blackish, with the upper and lower corners narrowly whitish. Ventral and pectoral blackish, with grayish posterior margins. Iris blackish-brown.

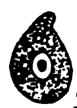
Length 5$\frac{5}{8}$ inches.

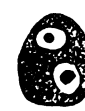
One example taken off of a large shark, evidently *Scolidon terræ-novæ*?, judging by a photograph, captured in Carson's creek at Biscayne Bay. It has 22 laminæ in the disk, and the median caudal rays project. I prefer the separation of this species from the Indian, until examples are compared.

NOSEMA GEOPHILI, sp. n., A MYXOSPORIDIAN PARASITE OF GEOPHILUS.

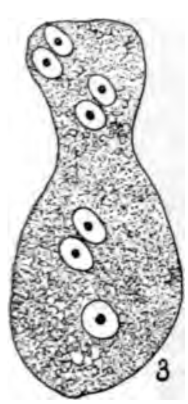
BY HOWARD CRAWLEY.

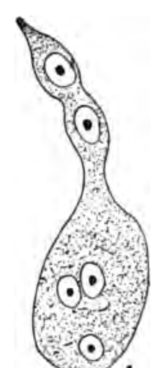
On May 21, 1900, a specimen of *Geophilus* was taken in the Harvard Botanical Garden, at Cambridge, Mass. The intestine of this centipede was teazed and crushed upon a slide, fixed in corrosive sublimate and stained with thionin. The preparation showed innumerable individuals of the vegetative stage of a coccidian, probably a species of *Eimeria*, and some 30–40 specimens of the parasite here figured and described.


1


2

Of these, the smallest, shown in figs. 1 and 2, were for the most part nearly oval cells, with occasionally a blunt prolongation at one end. They ranged in length from 30 microns upward. There was no distinction to be made out between ectoplasm and endoplasm, the cell substance being essentially uniform. It stained rather deeply with thionin, was dense in structure and beset with numerous vacuoles. No definite membrane could be made out.


3


4

These smaller bodies were mostly uninucleate, although in some the nucleus had already divided. The nuclei themselves were ellipsoidal bodies, with a faintly staining ground substance and a large and conspicuous karyosome. The ground substance was doubtless a liquid in the living animals. The karyosomes stained intensely in thionin and were in almost every case vacuolated.

The larger specimens, shown in figs. 3 and 4, attained a length of 150–200 microns. Their protoplasm was much less dense than that of the smaller forms, and showed a spongy structure. There was no differentiation into ectoplasm and endoplasm. The nuclei were generally arranged in pairs, indicative of recent division, but the prepara-

tion showed none in the actual process. The nuclei of both large and small organisms were essentially alike.

The irregular form and multi-nucleate condition of this sporozoan places it in the Myxosporidia. Its occurrence as a free-living form in either the body-cavity or intestine of an arthropod seems to warrant placing it, at least provisionally, in the genus *Nosema*. The specific name *geophili* is appropriate in view of the host.

The observation is interesting in view of the fact that this is the first recorded case of a myxosporidian being found in a myriapod. It is also worthy of note that while *Geophilus* is thus shown to be parasitized by representatives of three orders of Sporozoa, infection is only occasional. Léger, describing *Rhopalonia geophili*, a gregarine, says that it is very rare and I have never yet encountered it. I have seen the unidentified coccidian mentioned above in one or two other hosts, but the myxosporidian in only this one case. This comparative immunity is doubtless due to the solitary habit of the centipede.

MAY 5.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Thirty-nine persons present.

A revision of the By-Laws was adopted providing that hereafter (Chap. XII, Article 1) "the stated meetings of the Academy shall be held on the first and third Tuesdays of each month from October to May inclusive, at such hour as may be fixed by the Council; but no change shall be made in the hour except after one month's notice."

Also that (Chap. VII, Art. 4) "the Committee [on Publication] shall examine all papers intended for publication and shall print those approved by it as far as practicable in the order in which they were presented. It shall also prepare and print in the PROCEEDINGS abstracts from the minutes of the meetings of the Academy and summaries of verbal communications made to the Academy or any of its Sections."

The following were ordered by the Publication Committee to be printed:

A LIST OF ARACHNIDA FROM HAYTI, WITH DESCRIPTIONS OF NEW SPECIES.

BY NATHAN BANKS.

During the spring of 1899 Mr. R. J. Crew collected some spiders in Hayti, mostly from the vicinity of Port-au-Prince. Comparatively few spiders have been recorded from this island, and many of these are from other parts and are large spiders. According to my instructions Mr. Crew collected the smaller species, and thus secured a number of new forms, as well as others unknown from the region.

In all 63 spiders and 3 Phalangids were taken. The Epeiridæ with 17 species and the Attidæ with 15 species are more fully represented than the other families. Most of the spiders are known only from the West Indies, but about 17 species occur also in the southern United States. The following is the list:

ARANEIDA.

Scytodes longipes Lucas.
Scytodes fusca Walck.
Nops coccineus Simon.
Pholcus tipuloides Koch.
Wulfila parvula Banks.
Chiracanthium inclusum Hentz.
Aysha tenuis Koch.
Anyphæna gracilipes Banks.
Hypsinotus humilus Keyserling.
Trachelas bicolor Keyserling.
Eutichurus insulanus Banks.
Theridium studiosum Hentz.
Theridula sphærula Hentz.
Theridula triangularis Keyserling.
Floronia coccineus Hentz.
Argyrodes argyrodes Walck. (*nephilæ* Tacz.).
Argyrodes trituberculatus Becker.
Uloborus geniculatus Olivier.
Miagrammopes sp. (immature).
Tetragnatha sp. (female).
Argyroepeira argyra Walck.

Argyroepeira bigibbosa Keyserling.
Alcimosphenus licinus Simon.
Epeira theisii Walckenaer.
Epeira circulata Walck. (*balaustina* McCook).
Epeira fusco-vittata Keyserling.
Epeira undecim-tuberculata Keyserling.
Epeira foliata Hentz.
Eustala prompta Hentz.
Singa crewii Banks.
Cyclosa walckenaeri Keyserling.
Wagneria tauricornis Cambridge.
Acrosoma armatum Fabricius.
Gasteracantha hilaris Thorell.
Gasteracantha tetracantha Linnæus.
Gasteracantha cancriformis Walck.
Gasteracantha sexserrata Walck.
Misumena asperatus Hentz.
Misumena sp. (immature).
Stephanopis rugosa Taczanowski.
Isaloides toussaintii Banks.
Olios antiguensis Keyserling.
Heteropoda venatoria Linnæus.
Selenops insularis Keyserling.
Dolomedes marginellus Koch.
Oxyopes salticus Hentz.
Peucetia viridans Hentz.
Hamalatiwa grisea Keyserling.
Wala vernalis Peckham.
Wala peckhamæ Cockerell.
Plexippus paykulli Aud. and Sav.
Metacyrba pictipes Banks.
Nilakantha cockerelli Peckham.
Prostheclina perplexa Peckham.
Prostheclina morgani Peckham.
Prostheclina signata Banks.
Pellenes locuples Simon.
Mogrus cephalotes Simon.
Cybele haytiensis Banks.
Icius separatus Banks.
Synageles sp. (immature).
Lyssomanes viridis Hentz.
Lyssomanes antillianus Peckham.

Phalangida.

Cynorta obscura Banks.
Cynorta v-album Simon.
Stygnus insulanus Banks.

Descriptions of New Species.

Wulfila parvula n. sp.

Cephalothorax pale yellowish, black around eyes; mandibles red-brown; sternum yellowish; legs and abdomen paler, unmarked. The posterior eye-row procurved, P.M.E. fully diameter apart, about as far from the rather smaller P.S.E.; A.M.E. quite small, once and one-half their diameter apart, scarcely as far as the larger A.S.E., the latter close to and plainly smaller than the P.S.E., quadrangle of M.E. higher than broad, and broader behind than in front. Mandibles quite large; in the male very much elongate, nearly as long as femur I, tapering and divergent beyond middle, porrect, bearing a row of teeth below. Legs long and slender, three pairs of spines under tibiæ I and II, two pairs under these metatarsi. Male palpus long, on the upper side of the tibia is a row of short black spines, and a group of similar spines at the tip.

Length, ♂ 3.2 mm.; ♀ 2.8 mm.

Several specimens of both sexes.

Anyphæna gracilipes n. sp.

Pale yellowish throughout; dorsum of abdomen rather more grayish, with a few indistinct elongate gray streaks above; eyes on black spots. Eyes subequal in size, except those of the anterior median pair which are much smaller than the others. Posterior eye-row procurved; P.M.E. fully diameter apart, nearly as far from the equal P.S.E.; A.M.E. about diameter apart, very small, a little farther from the much larger A.S.E. Mandibles moderately long, but not porrect. Legs extremely long and slender, the anterior tibia nearly twice as long as the cephalothorax; the tibia and metatarsi I and II have each two pairs of very long spines beneath. Abdomen quite slender; the ventral furrow much nearer to the vulva than to the spinnerets. The epigynum shows two dark almond-shaped cavities, their pointed ends toward each other and curved backward.

Length 6 mm.

One specimen, female.

Singa crewii n. sp.

Cephalothorax pale yellowish, with a median blackish stripe, darker around eyes. Mandibles yellowish-brown; sternum pale, sides brown-

ish. Legs pale yellowish, tips of tibiæ dark; palpi pale on base, blackish beyond. Dorsum of abdomen pale grayish-white, with a broad gray folium, distinct in outline, but pale within, its anterior edges broadly marked with black, this black in front connects to the basal ends of the black side stripes, these stripes are broad black ones on each upper side of abdomen, below them the sides are pale yellowish; on the middle of the venter is a large black area, containing a central square pale spot.

It is of the usual structure of the genus, the legs, however, rather longer than usual.

Length 4 mm.

One female; a very pretty species.

Isaloides toussaintii n. sp.

Cephalothorax pale yellow, more brownish on the sides; mandibles, palpi and sternum pale yellowish; hind two pairs of legs pale yellow; anterior pairs more red-brown, with a pale spot beyond middle of tibia; abdomen pale gray, with a broad brown stripe from base to tip, with irregular sides, and covering the tubercles; venter pale, rather darker in the middle. Cephalothorax flat above, eye-region but little elevated; clypeus low; no dorsal groove; posterior row recurved, P.M.E. about one and one-half diameter apart, and fully as far from the P.S.E.; A.M.E. much lower down than A.S.E. so that the eyes are really in three rows, A.M.E. not half the size of P.M.E., but fully twice the diameter apart; A.S.E. fully twice as large as P.M.E. and about two diameters apart. Four pairs of spines under tibiæ I and II, three pairs under these metatarsi.

Length 6 mm.

Several specimens; differs from *I. octoperlata* Sim. in the shape of the vulva, as well as in minor characters.

Metacyrba pictipes n. sp.

Cephalothorax dark red-brown, a narrow white side-margin; abdomen greenish-brown, with a pair of parallel submedian pale lines above, made up of dots, rather indistinct; sternum dark red-brown; venter greenish-brown, with indistinct pale lines each side; tips of palpi white; mandibles reddish-brown; yellow hairs around eyes and on clypeus. Legs brown, tarsi white, a pale spot beneath on trochanters, patellæ above are almost wholly pale yellowish, an indistinct pale line above on femora and tibiæ, scarcely visible on the anterior pair.

Structure similar to *M. tæniola* Hentz.

Length 3.8 mm.

One male specimen, closely related to *M. tæniola*, but the male palpus has but one long projection on the tibia, the other is quite short; the legs are very differently marked than in *M. tæniola.*

Cybele haytiensis n. sp.

Cephalothorax reddish-yellow, with a median white spot with an extension each side and behind; eyes on large black patches; clypeus pale; mandibles pale, with a brown band across middle; sternum and legs pale, the latter with some small brown patches at base of joints and on the tibia near middle; abdomen pale, with gray-brown dots and an irregular stripe each side; venter pale. Male similar, but the side stripes from the median pale mark are indistinct; the anterior pair of legs is infuscate; the mandibles are brown; the venter is black; and there is a black stripe on the ventral side of each coxa. The epigynum shows two large circular marks quite close to each other, and in front two divergent curved lines; the male palpus is quite simple, the tibia is long and with a long, straight projection on the outer side at tip.

Length, ♀ 7 mm., ♂ 5.5 mm.

A few specimens of both sexes. Evidently related to *C. albopalpis* Peck., from Jamaica.

Icius separatus n. sp.

Cephalothorax yellowish-brown, clothed with white and yellowish scales and scattered long black hairs; eyes on black spots, and a transverse black patch in the middle of the eye-region. Mandibles red-brown; sternum pale; legs very pale, the anterior pair more yellow, and its joints tipped with blackish, other legs unmarked. Dorsum of abdomen pale gray, with several large median brown spots forming an incomplete median stripe; each side are many small brown spots; the sides of the abdomen with brown lines; the venter pale; the spinnerets reddish.

The cephalothorax is rather low and flat, and quite short; the eye-region is plainly broader behind than in front, and about once and a third broader than long; the A.S.E. are as high as the A.M.E., the latter very large and touching; the eyes of second row are nearer to lateral than to dorsal eyes. Leg I, which is rather longer than leg IV, is much enlarged, five stout spines on femur I, three pairs under tibiæ I and II, two pairs under same metatarsi; metatarsus III spined only at tip; anterior coxæ separated by width of lip; abdomen short and flat.

Length 3.2 mm.

One female specimen.

EXPLANATION OF PLATE XV.

Fig. 1.—*Cybele haytiensis.*
Fig. 2.—*Wulfila parvula*, vulva.
Fig. 3.—*Isaloides toussaintii*, vulva.
Fig. 4.—*Wulfila parvula*, palpus.
Fig. 5.—*Icius separatus*, eyes.
Fig. 6.—*Anyphæna gracilipes*, eyes.
Fig. 7.—*Metacyrba pictipes*, palpus.
Fig. 8.—*Singa crewii*, vulva.
Fig. 9.—*Cybele haytiensis*, vulva.
Fig. 10.—*Anyphæna gracilipes*, vulva.
Fig. 11.—*Icius separatus*, vulva.
Fig. 12.—*Cybele haytiensis*, palpus.

NOTES ON A FEW FISHES FROM THE MOSQUITO COAST OF NICARAGUA.

BY HENRY W. FOWLER.

A few fishes have recently been received at the Academy of Natural Sciences of Philadelphia from the Rev. William H. Fluck. They were collected at Waûnta Haûlover, which is on the Mosquito coast or Atlantic seaboard of Nicaragua. Though none are new, they prove of interest on account of the locality.

SILURIDÆ.

FELICHTHYS Swainson.

1839. Nat. Hist. Fish. Amph. Rep., II, p. 305.

Type *F[elichthys] filamentosus* Swainson, *l. c.* Based on *Silurus bagre* Bloch, Ichthyologie, IV, Pt. 11, 1797, p. 19, Pl. 365. "Les grand rivières du Brésil et de l'Amerique septentrionale." (Coll. M. de Burgsdorff Conseiller.) [Not of Linnæus.]

1. Felichthys marinus (Mitchill).

1815. *Silurus marinus* Mitchill, Trans. Lit. Philos. Soc. New York, I, p. 433. "New York. Taken June 30th, 1814."

Head $3\frac{1}{5}$; depth $4\frac{4}{5}$; D. I, 7; A. VIII, 16; P. I, 13; V. I, 5; width of head $1\frac{1}{4}$ in its length; depth of head, at posterior margin of the opercle, $1\frac{2}{5}$; snout $2\frac{5}{8}$; eye 5; width of mouth 2; interorbital space $1\frac{2}{3}$; internasal space 3; base of the dorsal $2\frac{2}{7}$; dorsal spine $1\frac{1}{5}$; least depth of caudal peduncle $3\frac{3}{5}$; base of anal $1\frac{2}{3}$; first branched anal ray $1\frac{3}{4}$; ventral $1\frac{3}{4}$.

Body rather long, depressed at first, then compressed after the head, and the greatest depth at the origin of the dorsal fin. Caudal peduncle compressed, and its least depth about half its length, measured between the posterior base of the adipose dorsal, and the base of the caudal.

Head broad, depressed, more or less flattened below, and rising convexly above, especially to the dorsal fin. Upper profile of the head a little convex above the eye in front. Occipital buckler solid, its width in front about equal to its length. Snout broad, a little rounded when viewed from above, and projecting a little beyond the mandible. Eye lateral, rather large, and its posterior margin about midway in the length of the head, viewed laterally. Mouth broad, rounded, and with

rather thin lips. Teeth minute, and in rather narrow bands in the jaws, and on the vomer and palatines. Tongue thick, broad, rounded, and free in front. Nostrils close together, the anterior circular, directed forward just above the lip, and the posterior elongate with a small flap. Interorbital space convexly elevated, with a median depression giving place to the fontanelle. The fontanelle does not extend beyond the eyes, but runs back to the occipital process as a narrow median groove. Maxillary barbels broad, flattened, and reaching to the anus. Mental barbels short, two in number, and reaching a little beyond the gill-membrane where it crosses the isthmus.

Gill-opening extending forward nearly opposite the posterior margin of the eye.

Peritoneum pale.

Anus about the last third in the space between the origin of the ventral and that of the anal.

Skin smooth, the top of the head posteriorly, and the occipital buckler rather rugose. Humeral process smooth. Lateral line with many rather long straight and obliquely vertical branches running out above and below. The lateral line itself is continued well out on the basal portion of the caudal.

Origin of the dorsal nearer the tip of the snout than the origin of the anal, the spine straight, with a rugose edge in front becoming barbed above, and giving place above to a long compressed broad filament that reaches near the base of the caudal. Dorsal rays graduated from the first, which is much longer than the spine, to the last, which is a little over a third the length of the spine. Adipose dorsal much higher than its base, and inserted much nearer the base of the caudal than the base of the last dorsal ray. Anal with a slightly concave margin, the first developed ray the highest, and the origin much nearer the base of the caudal than the origin of the dorsal. Pectoral with a long compressed spine, rugose along the edge at first, and both edges barbed distally. When depressed the spine reaches three-fourths the distance to the ventral, and its extremity gives place to a long compressed filament reaching the origin of the anal. First pectoral ray longer than the spine, and the others graduated to the last which is about a fourth the length of the spine. Ventral broad, rounded, the spine more or less flexible, and reaching the anal fin. Caudal large deeply forked, and the lobes long, rather slender and pointed.

Color in alcohol grayish above, white below. Lower side with crowded gray dots. The outer lower surface of the pectoral with

crowded gray dots. On the outer portion of the anal they are fewer. Ventral with only a few gray dots above. Upper edge of the maxillary barbels with gray dots. Lips whitish.

Length $8\frac{1}{2}$ inches.

One example. This is evidently the young of *marinus*, though I have never seen any young examples before. It agrees with adult and rather large examples from the New Jersey coast.

HÆMULIDÆ.

CONODON Cuvier.

1830. Hist. Nat. Poiss., V, p. 116.

Type *Conodon antillanus* Cuvier. *l. c.* "Jamaïque." (Coll. M. Broussonnet.) [=*plumieri*.]

2. Conodon plumieri (Bloch).

1797. *Sciæna plumieri* Bloch, Ichthyologie, III, Pt. 9, p. 57, Pl. 306. "Antilles."

Head 3; depth $3\frac{1}{4}$; D. XII, 12; A. III, 7; scales 52 in the lateral line to the base of the caudal; 6 scales between the origin of the dorsal and the lateral line in a vertical series, and 12 between the latter and the origin of the anal; fourth dorsal spine $1\frac{7}{8}$ in the head; second dorsal ray $2\frac{3}{4}$?; pectoral $1\frac{1}{5}$; snout $3\frac{1}{3}$ in the head, measured from the tip of the upper jaw; eye $4\frac{1}{4}$; maxillary $2\frac{7}{8}$; interorbital space 5.

Back elevated and compressed, the greatest depth at the base of the second dorsal spine. Least depth of the caudal peduncle one and two-thirds in its length.

Upper profile of the head a little convex. Snout broad, convex, with the upper jaw projecting, and the upper profile a little convex. Eye high, impinging on the upper profile of the head, and its posterior margin about midway in the length of the same. Preorbital margin undulate. Maxillary reaching opposite the first fifth of the eye, and its distal expanded portion a little less than half. Lips thick and fleshy. Bands of minute teeth in the jaws, with $\frac{3-3}{3-3}$ large conic canines in the front of each jaw forming an outer series. Tongue broad, round, and free in front. Nostrils large, close together at the front of the eye, circular, and the posterior about half the size of the anterior. Interorbital space flattened. Margin of the preopercle with sparse short serrations, ending in a spine below, and its lower edge with a series of short spines directed forward.

Gill-opening extending about opposite the posterior fourth of the eye. Gill-rakers 6+16, pointed, more or less even, and a little shorter

than the filaments, which are a little less than half the eye. Pseudobranchiæ rather short.

Peritoneum pale.

Scales of more or less even size, and finely ciliated. Vertical fins mostly scaly. Small scales crowded at the humeral region, at the base of the pectoral, and out on the basal portion of the fin. A flap composed of a few small scales at the axil of the pectoral. A few pointed scales at the base of the ventral, but not free. Lateral line nearly concurrent with the dorsal profile, composed of simple tubes, and extending well out on the caudal basally.

Origin of the dorsal inserted well behind that of the pectoral, the spines graduated to the fourth which is the longest, the first a little longer than eleventh, and the twelfth about equal to the second. Origin of the soft dorsal about midway between that of the spinous dorsal and the base of the caudal, and the anterior rays the longest. Spinous anal inserted a trifle behind the origin of the soft dorsal, the second spine the longest, much longer than the first or longest ray, and the base of the rayed fin a trifle over half its height. Pectoral pointed, reaching about three-quarters of the distance to the anal. Ventral inserted behind the pectoral, reaching about three-quarters of the distance to the anus, and the spine about two-thirds the length of the fin.

Color in alcohol brown above, pale beneath. About eight vertical brown bands or bars along the side of the body, extending till opposite the base of the pectoral.

Length $6\frac{11}{16}$ inches.

One example.

I do not accept *Perca nobilis* Linnæus[1] as the earliest available name for this species, as he states D. $\frac{1}{2}\frac{3}{5}$, A. $\frac{3}{10}$! MM. Jordan and Feslar contend that it is probably intended for this species, though they admit that there is less doubt about the name *plumieri*.[2]

CICHLIDÆ.

HEROS Heckel.

1841. Zool. Abhand. Annel. Wien. Mus. Nat., 1841, p. 362.

Type *Heros severus* Heckel, *l. c.* "Marabitanas im Rio-negro." (Coll. M. Natterer.)

3. Heros urophthalmus Günther.

1862. *Heros urophthalmus* Günther, Cat. Fish. Brit. Mus., IV, p. 291. "Lake Peten." [Guatemala.] (Coll. MM. Salvin and Godman.)

Head $2\frac{1}{2}$; depth $2\frac{1}{4}$; D. XVI, 11; A. VI, 9; scales 30 in a lateral

[1] *Syst. Nat.*, Ed. X, I, 1758, p. 291.
[2] *Rep. U. S. Fish. Comm.*, XVII 1893, p. 488.

series to the base of the caudal; 5 scales in an oblique series back from the origin of the spinous dorsal to the lateral line, and 11 between the latter and the origin of the anal; fifth dorsal ray $1\frac{6}{7}$ in the head; sixth anal spine $2\frac{1}{2}$; fifth dorsal ray $1\frac{5}{8}$; caudal $1\frac{1}{4}$; pectoral $1\frac{1}{2}$; ventral $1\frac{2}{5}$; least depth of caudal peduncle $2\frac{3}{5}$; snout $2\frac{2}{3}$ in the head, measured from the tip of the upper jaw; eye $4\frac{2}{5}$; maxillary $3\frac{1}{10}$; interorbital space $3\frac{1}{3}$; width of preorbital 5.

One example, $5\frac{3}{16}$ inches in length. It is more slender than the examples examined by MM. Evermann and Goldsborough,[3] and the black caudal spot at the bases of the upper caudal rays is very distinct. There is also a certain amount of dusky about the bases of the vertical fins, and the outer anterior portion of the ventral.

TETRAODONTIDÆ.

4. Cheiliohthys testudimeus (Linnæus).

Four small examples, the largest $3\frac{3}{8}$ inches long. They agree with examples from Porto Rico. There are a number of rather large dark spots on the flank, but not so numerous as in the adult.

SOLEIDÆ.

BAIOSTOMA Bean.

1882. In Goode and Bean, Proc. U. S. Nat. Mus., V, p. 415.

Type *Baiostoma branchialis* Bean, *l. c.* "Appalachicola Bay, South Florida." (Coll. M. Silas Stearns. Nos. 26,605, 30,463, U. S. Nat. Mus.)

This group is given generic rank on account of the presence of small pectoral fins, developed at least on the right side. In *Achirus* they are wholly wanting.

Grammichthys Kaup is hardly available as his type, *Pleuronectes lineatus* Linnæus, appears to be of the Ed. XII, *Syst. Nat.*

5. Biastoma lineata (Linnæus).

1758. [*Pleuronectes*] *lineatus* Linnæus, Syst. Nat., Ed. X, p. 268. "America." Based on *Pleuronectes* 1. *Fuscus subrotund., etc.* Browne, Civ. Nat. Hist. Jam., III, 1756, p. 445. [Jamaica.]

D. 53; A. 40; scales 76 in a lateral series between the gill-opening and the base of the caudal. Pectoral well developed on the right side with five rays.

One example, $2\frac{5}{8}$ inches in length.

[3] *Bull. U. S. Fish Comm.*, 1902, p. 157.

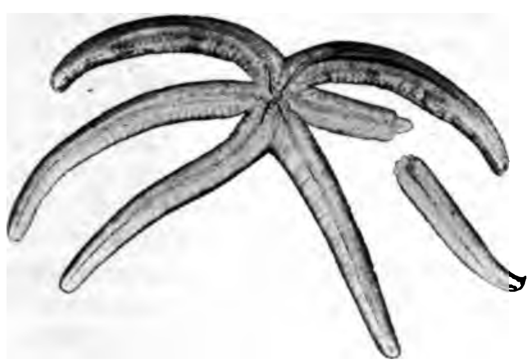
MAY 19.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Twenty-one persons present.

Regeneration of the Body of a Starfish.—MISS SARAH P. MONKS, in a note read to the meeting, stated that it had been known for many years that starfish can renew rays that have been removed. "It has been stated that in certain starfishes an arm itself can produce a new starfish—Haeckel, Sarasin, von Martens and Saris—but this has been denied by other observers."[1] It is believed by some that a portion of the disk must remain if there is any regeneration, and the breakage plane is near the body, or disk, in cases of renewal of arms.

In studying regeneration of *Phataria* (*Linckia*) *fascialis* she had cut arms at different distances from the disk, and a number of the single rays produced new bodies. The free ray made a new body and the rest of the starfish produced a new ray, and there was very little difference in the rate of growth of each, and no definite place for breaking.



In the photograph of a six-rayed *Phataria*, the cut ray attached to the body shows a small ray sprouting, while the free ray shows four new rays. This was cut July, 1902, and the photograph taken February, 1903.

The manner of growth is as follows: The cut edges heal and draw down toward the oral side of the starfish, then small knobs appear at the end which grow into rays in which the ambulacral furrow soon appears, with the small mouth in the center of the rays.

She had collected specimens at San Pedro, Cal., showing all stages of growth of the single arm, from the recently broken arm to those like the photograph on through all sizes of growing rays.

The following have been accepted by the Publication Committee and ordered to be printed:

[1] *Regeneration*, Morgan, p. 102.

THE FORM AND STRUCTURE OF THE MYCODOMATIA OF MYRICA CERIFERA L.

BY JOHN W. HARSHBERGER, PH.D.

Within the last decade or two considerable progress has been made in our knowledge of the enlargements, galls, tubercles and coralline outgrowths on the roots of the higher chlorophyll-bearing plants. Some of them are due to insects, others are due to a perversion of the physiologic activities of the plants on which they are found, while others are attributable to the stimuli occasioned by bacteria, slime moulds and higher fungi. Our information concerning the tubercles on the roots of the Leguminosæ is reasonably complete, thanks to the energies of Hellriegel, Willfarth, Winogradsky and others. Magnus[1] has summed up our knowledge of the growths produced by subterranean fungi in a recent paper. He describes systematically the fungi known to live as subterranean parasites, but barely mentions those forms of enlargement called mycodomatia. Mycodomatia were known to the botanists of a century ago. Meyen[2] looked upon them as parasites having a habit in this respect similar to plants of the natural orders Balanophoraceæ and Orobanchaceæ. Schacht,[3] who was the first to give a fairly satisfactory account of their external appearance, regarded them as normal growths upon roots, but later he considered them as abnormal. Jäger[4] considered them as due to insects. Woronin,[5] in a paper published in the Memoirs of the Academy of Sciences of St. Petersburg, believed that the coral-like swellings on the roots of the black alder were due to a fungus closely related to one described by Nägeli inhabiting the roots of various species of Iris and called by him

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[1] MAGNUS, P., "Unsere Kenntniss unterirdisch lebender streng parasitischer Pilze und die biologische Bedeutung eines solchen unterirdischen Parasitismus," *Abhandlungen des botanischen Vereins der Provinz Brandenburg*, XLIV (1902), pp. 147–156.

[2] MEYEN, "Ueber das Hervorwachsen parasitischer Gewächse, etc.," *Flora*, 1829, S. 49.

[3] SCHACHT, "Die Pflanzenphysiologie und Herr Dr. G. Walpers in Berlin," *Flora*, 1853, pp. 1–13; also "Der Baum," 1860, S. 172–174.

[4] JÄGER, "Ueber eine Krankhafte Veränderung der Blüthen Organe der Weintraube," *Flora*, S. 49.

[5] WORONIN, "Ueber die bei der Schwarzerle (Alnus Glutinosa) und der gewöhnlichen Garten-Lupine (Lupinus mutabilis) auftretenden Wurzelausschwellungen," *Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg*, VII Serie, Tome X, No. 6, 1866.

cellulicola. Magnus denied that the similarity was sufficient the two fungi together. Some work done by Gravis[6] led to make a more detailed study of young galls upon *Alnus.* was so much impressed with the resemblance to his *Plasmo-brassicæ,* that he communicated to Gravis his belief that two ıs were present, one a slime mould and the other a fungus. these preliminary observations similar galls have been found *s incana, Alnus serrulata, Alnus undulata, Ceanothus ameri-lyrica gale, Hippophæ rhamnoides,* and on species of *Elæagnus pherdia,* and last summer on *Myrica cerifera* by the writer. lts of his study of the mycodomatia on the roots of the common y form the material for this paper. Tabulated the names of s on which mycodomatia occur and the names of the fungi ıg them is as follows:

us glutinosa	*Frankia alni* (Möller) Atkinson.
incana	" " " "
serrulata	" " " "
undulata	" " " "
nothus americanus	*Frankia ceanothi* Atkinson.
rica gale	*Frankia brunchorstii* Möller.
' *cerifera*	" " "
agnus	*Frankia alni* (Möller) Atkinson.
pophæ rhamnoides	" " " "
pherdia	" " " "

tory of the synonymy is somewhat as follows: Woronin first ed the parasite to belong to the genus *Schinzia* of Nägeli. showed the untenableness of this position. Woronin, after tailed study, referred the parasite to the slime mould genus *Plas-ora,* and in this view he was supported by H. Möller,[7] who t *Plasmodiophora alni.* Brunchorst,[8] correctly interpreting ıre of the parasite to be a true filamentous fungus, established ıs *Frankia* and named it *Frankia subtilis,* ignoring the oldest name *alni.* Möller in 1890, by a study of fresh material instead olic, set aside his former position and corroborated the observa-Brunchorst that the organism was a filamentous fungus. He

ıs, "Observations anatomiques sur les excroissances des racines de *Bulletin de la Société royale de Botanique de Belgique,* Tome XVIII, pp. 50–60.
ER, H., "Plasmodiophora alni," *Berichte der deutschen botanischen ıft,* Bd. III, 1885, pp. 102–105.
CHORST, "Ueber die Knöllchen an den Wurzeln von Alnus und den een," *Botanisches Centralblatt,* XXIV, p. 222, 1885.

also described the parasitic growths on another plant, viz., *Myrica gale*, and named it as a new species, *Frankia brunchorstii*.[9] Atkinson[10] gave a complete and useful summary of the literature when he published his paper in 1892. He described a new species of *Frankia* producing galls on the roots of the New Jersey tea, *Ceanothus americanus*, which he called *Frankia ceanothi*. The mycodomatia on *Elæagnus*, *Hippophæ* and *Shepherdia* are considered to be due to a parasite identical with *Frankia alni* occurring on the genus *Alnus*. We have, therefore, three named species of this genus, viz., *Frankia alni* (Möller) Atkinson occurring on four distinct genera of phanerogamous plants, *Frankia ceanothi* Atkinson on the single genus *Ceanothus*, and *Frankia brunchorstii* Möller on the genus *Myrica*.

The discovery of mycodomatia on a new host, viz., *Myrica cerifera*, has led the writer to make a careful study of the galls and the fungus that produces them. The mycodomatia were discovered on waxberry bushes growing on the slopes of sand dunes at Sea Side Park, N. J., where they were laid bare by the blowing away of the sand from about the plants. Originally the bushes grew out of a low dune, and as the sand drifted in about their stems adventitious roots were formed upon which grew the fungous galls, or the mycodomatia. As will be shown subsequently, the fungus is perennial and the growth of the mycodomatia is an extremely slow one. This slow growth argues for the stability of the dune on which the bushes grew, for if the sand had been constantly shifting the roots could not have been buried sufficiently long to permit of the growth of the fungous galls to the size that they had reached when they were uncovered. We have, therefore, a means of measuring the length of life of certain sand dunes. It seems to the writer that the discovery of these mycodomatia on the adventitious roots of the waxberry growing in the pure sand of the New Jersey dunes throws light upon the question of the importance of these mycodomatia to the host plant.

It has been shown by the experimental work of a number of observers that leguminous plants will grow in pure sand after the period of starvation is passed, provided such sand be microbe-seeded, *i.e.*, provided the right kind of tubercle bacterium is present in the sand. Subsequent chemical analysis of plants thus grown has shown that nitrogen over and above the amount present in the seed is found in such legu-

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[9] MOLLER, "Beitrag zur Kenntniss der Frankia subtilis Brunchorst," *Bericht der deutschen botanischen Gesellschaft*, VIII, 1890, pp. 215–224.

[10] ATKINSON, GEORGE F., "The Genus Frankia in the United States," *Bulletin of the Torrey Botanical Club*, XIX (1892), pp. 171–177.

minous plants, and the inference is that the tubercle-producing bacteria have been instrumental in the production of various nitrogenous compounds derived directly from the nitrogen of the atmosphere. It is customary in the poor sandy soil of northern Germany, near Berlin, to grow a great variety of leguminous plants, prominently the yellow lupine. The yellow lupine is plowed under and enriches the sandy soil by the decomposition of the nitrogenous substances present in the roots, stems and leaves. The fact that such plants thrive in such poor sandy soil is explained by the activity of the bacterial symbiont. The writer has observed the beach pea, *Lathyrus maritimus*, growing on the crest of the sea dunes of the New Jersey coast. That the soil is enriched by the growth of this plant is evidenced by the more luxuriant development and darker green color of the marram grass, *Ammophila arenaria*, which grows associated with the beach pea on the dunes. Thus the writer previously argued, taking for granted that Frank's assumption was correct, that mycodomatia have a similar function to the leguminous tubercles. But a more careful study has led him to believe that too much has been taken for granted with reference to the function of mycodomatia.

The abundance of the mycelia in the mycodomatia surprised him and led him to question the validity of the position taken by some of the earlier observers that the mycodomatia act in the same way as the leguminous tubercles. It is probable that *Frankia brunchorstii* is more in the nature of an endotrophic mycorhiza, to be placed intermediate between the ectotrophic mycorhiza found on the Indian pipe *Monotropa*, the short roots of which resemble closely in external appearance mycodomatia, and the typical endotrophic mycorhiza found in *Thismia* and certain other plants, where a definite relationship is established between the nucleus of the host and the fungous hyphæ. No such nuclear control of the growth of the fungus *Frankia* is observed in the mycodomatia of *Myrica cerifera*. The action of the mycelium of *Frankia* is much more severe, and in fact its growth suggests a true antagonistic symbiosis, for the host cells finally suffer the loss of their protoplasmic contents and collapse, leaving the fungus in possession of the older portions of the mycodomatia. Whether the waxberry derives any benefit from the association of *Frankia* with its roots can be determined only by careful physiologic experimentation. However, if we have here a true instance of parasitism, the struggle between host and fungus is long drawn out, and no material damage is done to the host as long as the fungus confines its attack to the secondary roots of the waxberry. If this view

is correct, then the galls on the roots of *Myrica* are mycocecidia and not mycodomatia, applying these terms as first suggested by Frank.

The mycodomatia (Pl. XVI) examined by the writer all grew upon the short adventitious roots formed when the stems of the waxberry bushes were covered by the blowing of the sand around them. On some smaller secondary roots the galls simply dichotomize, but later, by the increase in number of these forking fiber-like swellings, they become aggregated together into nests or clumps about the size of a walnut (Pl. XVI). The dichotomous fibers that compose the mycodomatia are of a rich umber-brown color. They grow in length by small increments and repeatedly branch in a forking manner. On a small stem examined, the fibers developed on the adventitious roots surround the dry remains of the underground rhizomes of the marram grass, *Ammophila arenaria*. The dead leaves and wiry stem of this grass are mixed with the fiber-like galls by the repeated branching of the galls among this material. The tips of the brown fibers that together form a fungous household, or mycodomatium, are in the dried specimens blunt and rounded. Their appearance seems to indicate that, when fresh, they were of a lighter color and softer in consistency than the older part of the swelling. The lighter color of the tip probably indicates the growth of the year. A measurement of several such apices shows that the growth is extremely slow, rarely exceeding a millimeter or two in a single season. Some of the branches of the mycodomatia measure twelve and fourteen millimeters in length. If the yearly increment is one millimeter, such branches are twelve and fourteen years old. If the annual growth is two millimeters, six or seven years represent the age of some of the branches. A conservative estimate of the age of the mycodomatia that have reached the size of walnuts is ten to fifteen years. If the growth in the length of the branches of the mycodomatia is greater than this, then this estimate is too high. One waxberry stem thirty-two millimeters in diameter with several mycodomatia on its secondary roots shows twenty-two annual rings of wood, and twenty years would be the outside limit of the age of mycodomatia growing on such stems. When dried the branches of the mycodomatia become extremely brittle, and the specimens kept for the botanical museum suffered severely in being carried from the seashore to the botanical laboratory.

The microscopic structure of the galls is of interest because few of the earlier observers seem to have determined satisfactorily the exact character of the parasite. Thus Woronin[11] considered the parasite to

[11] WORONIN, *loc. cit.*

be a fungus similar to Nägeli's *Schinzia*. A paper by Gravis led him to modify his views by ascribing the galls to the combined action of a myxomycete similar in appearance to his *Plasmodiophora brassicæ* and a fungous mycelium. Möller[12] claimed that the galls were due to a slime mould. Warming[13] attributed the formation of the mycodomatia to a slime mould allied to the genus *Plasmodiophora*. Brunchorst,[14] by his excellent observations, set the matter straight by attributing the galls to a filamentous fungus and established the genus *Frankia* for it. Woronin, Frank,[15] Sorauer[16] represented several so-called sporangia in the cells of the several hosts studied attached to single threads of the mycelium. Brunchorst attempted to prove the fallacy of the observations of these workers by showing that by an optical illusion the sporangia which appear attached in reality lie over the fungous hyphæ. Atkinson[17] figures and describes the mycelium and sporangia of a filamentous fungus which he called *Frankia ceanothi*, because the parasite lived in the roots of the New Jersey tea, *Ceanothus americanus*. With this contradictory evidence a more careful microscopic examination of the mycodomatia is necessary.

Sections were made of the branches of mycodomatia by first boiling the dried specimens and then treating them with thirty-five per cent. alcohol to remove part of the air. Transverse and longitudinal sections were made of the dichotomously branched root-like galls. The general microscopic structure of one of these mycodomatial swellings resembles that of a root (Pl. XVII, fig. 1). The center of the section is occupied by the cylinder of wood or xylem, which, however, lacks the larger open elements of the wood of a normal root. The tracheids, irregular in shape and much reduced in size, are compacted together and the medullary rays are displaced out of their true radial position, taking a somewhat sinuous instead of a straight course (Pl. XVII, fig. 1). Both in the normal and in the fungous-infested tissues, the medullary ray cells have contents of a rich brown color. External to the wood comes the cambium, theoretically of a single layer of cells, and outside of this the soft bast which consists of rounded cells. In such roots, where the elements have shifted normally from a radial position, the cortex and soft bast are confluent, both in the normal and in the fun-

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[12] Möller, *loc. cit.*

[13] Warming, "Wurzelknöllchen bei den Elæagnen," *Just's Botanischer Jahresbericht*, 1876, IVa, p. 439.

[14] Brunchorst, "Ueber die Knöllchen an den Wurzeln von Alnus und den Elæagnaceen," *Botanisches Centralblatt*, XXIV, 1885, p. 222.

[15] Frank, "Krankheiten der Pflanzen," p. 647.

[16] Sorauer, "Pflanzenkrankheiten."

[17] Atkinson, *loc. cit.*

gous material. In the older normal roots, the cortex is delimited by a discontinuous layer of hard bast patches, a few elements of which are occasionally met with in the galls. External to the rather abundant brown cortex region of normal and fungous inhabited roots is a phellogenetic layer, succeeded at the periphery by the young and old cork cells. Where branches arise, a section at such places shows the obliquely cut xylem pushing out surrounded by the cortex cells. The young light-colored cork cells at such places become confluent with the similarly colored wood cells, so that it is difficult to distinguish between the elements composing these two distinct kinds of tissue. Another marked feature in both the normal and parasitized roots is the plugged tracheids with a yellowish or brown gummy material,[18] whether in the nature of modified tyloses the writer was unable to determine. The most highly modified portions of the roots of *Myrica cerifera*, when parasitized by *Frankia brunchorstii*, are the woody cylinder, the soft bast and the cortex.

The finest fungous mycelium is found in the cortex of the younger roots and growing into the medullary ray cells. It consists of fine unicellular hyphæ and can be made out with the greatest difficulty by a No. 3 Leitz objective. With a No. 7 Leitz objective, the finer hyphæ become defined as cobweb-like threads stretching across the large, lacunar, intercellular spaces which have been formed between the rounded cortex cells near the apical portion of the swelling (Pl. XVII, fig. 6*b*). Sometimes the hyphæ stretch straight across these intercellular spaces, but more often they take a sinuous course and form a complex where several branches cross each other (Pl. XVII, fig. 3). These finer hyphæ are formed as branches from thicker brown hyphæ to be described later.

The course of the hyphæ, as revealed in a longitudinal section of the apical portion of the mycodomatial branches, is in general from cell to cell. The hyphæ may pass from one side of the cell to the other, passing out again through the cell wall, or the hyphæ may make a loop, a half turn or branch by the formation of short branches (Pl. XVII, fig. 6). These short branches are found imbedded in the protoplasm of the cortex cells and may be looked upon in some sense as haustoria. Sometimes several hyphæ run into one host cell, and in such cases the branches form a mesh. The hyphæ also grow intercellularly. In several transverse sections studied, three hyphæ parallel to each other pierce the same cell wall and run through the protoplasm of the cell

[18] HARSHBERGER, "Two Fungous Diseases of the White Cedar," *Proc. Acad. Nat. Sci. of Phila.*, 1902, p. 461.

thus entered. The course of such hyphæ from cell to cell is made clearer by the contraction of the protoplasm from the cell wall. This condition has been produced by drying and the protoplasm has been plasmolyzed. Two hyphæ enter the protoplasm of a cortex cell, converge near the center of the cell, and then run to the opposite cell wall, where just before passing through it they diverge from each other. Another hyphæ enters a cell, and in the center of it forks to form a Y (Pl. XVII, fig. 6*b*). Still other hyphæ in transverse section grow through the triangular intercellular spaces, forming perfect complexes.

In the older sections, hyphæ are seen of a larger size and with browner walls than the finer hyphæ above described (Pl. XVII, figs. 2, 4). These seem to take a general longitudinal or oblique course through the cortex, because in several transsections studied these hyphæ exist as rings lying in the cells, having been cut across by the razor. Large brown hyphæ are seen in the lacunar intercellular spaces of sections made at the base of mycodomatial swellings (Pl, XVII, figs. 2 and 4). These hyphæ are the main trunks of those that pierce the cells and grow into the protoplasm, for they produce smaller branches which assume the colorless aspect of the finer hyphæ already described (Pl. XVII, fig. 6*b*). It is, therefore, clear that the apical portions of the mycodomatia have fine hyphæ with a few thicker strands, while sections cut from the older and basal portions of the swellings have large, brown, thick-walled, unicellular hyphæ which run longitudinally and obliquely. The larger hyphæ probably form the older and perennating mycelium which, during the life of the metamorphosed secondary roots, seem to provide new and finer hyphæ to the apical portion of the branches of the mycodomatium.

The larger unicellular hyphæ, which can be followed across the large irregular lacunar spaces formed by the rupture of the cortex in drying, enter cortex cells where they branch by the formation of short rounded sickle-shaped branches (Pl. XVII, fig. 3). Several of these curved branches may be formed from a single hypha. These may be looked upon in the nature of haustoria. Sometimes these branches, especially near the apical portion of the mycodomatia, become extremely fine, and then they may grow between the starch grains imbedded in the protoplasm, forming a meshed structure to be referred to later (Pl. XVII, fig. 6*a*). The larger number of these brown thick-walled hyphæ are found in the medio- and endocortex, and they almost fill both the cells of these regions and the intercellular spaces. The cortex cells are no longer living in these reigons, but by the growth of the parasitic hyphæ they have been destroyed as living cells. However, at the

apex of the mycodomatial growths the cortex cells are still alive and by slow growth add to the length of the several branches, forming a mycodomatium. This stage of the fungous development is sometimes found on secondary roots which still show a radial structure with a well-defined endodermis. In such roots the fungus is found especially well marked in the medio- and endocortex and to a limited extent in the exocortex.

One section showed an appearance suggestive of sporangia as figured in Woronin's paper of 1866, cited above. The writer refers to certain cortex cells which have contents not only reticulate with clear rounded areas enmeshed by the yellowish reticulum, but also suggestive of a lattice-work of protoplasm (Pl. XVII, fig. 6*a*). Hyphæ are connected not only with the protoplasmic reticulum, but also with the open basket-like protoplasm, so as to suggest that the protoplasmic reticulum owes its origin to the mycelium. A careful study, however, of the relationship of fungus and host cells shows that the reticulum owes its genesis to imbedded starch grains which have been partially dissolved away by the treatment of the sections in mounting, and that hyphæ have sent in short branches between the starch grains and hence into the meshes of the protoplasmic reticulum (Pl. XVII, fig. 6*a*). This may have suggested to Woronin the sporangia (zooconidia) which he figures in a grape-like bunch in the cell, each sporangium (zooconidium) connected by a hypha. Or this reticulate structure may have suggested to Möller[19] a plasmodium of a myxomycete like *Plasmodiophora* dividing up into a number of spores.

The writer believes that in suggesting this he has reconciled the earlier opposing views. Woronin is probably right in describing the sporangia (zooconidia) of *Frankia*, because the mycelium and its manner of growth suggests a relationship to the genus *Pythium*, and the writer would place, therefore, tentatively, the hyphomycetous genus *Frankia* among the *Oomycetes*, close to the genera *Pythium* and *Peronospora*. This view is strengthened if the lattice-like reticulum mentioned above (Pl. XVII, fig. 6*a*) is compared with a figure (fig. 28) given by Tubeuf on p. 139 of his text-book. This figure illustrates the growth of the fungous *Phytophthora* in the tissues of the leaf of the beech, and the same kind of reticulum is shown.

In the absence of oogonia and zooconidia, however, in the mycodomatia of *Myrica cerifera*, the suggested relationships of the fungus studied by the writer to the *Oomycetes* cannot be insisted upon. The

[19] MOLLER, "Beiträg zur Kenntniss der Frankia subtilis Brunchorst," *Berichte der deutschen botanischen Gesellschaft*, VIII, 1890, p. 222.

unicellular hyphæ, the method of growth of the haustoria and the appearance of the sporangia (zooconidia) figured by Woronin are all strongly suggestive of such a kinship.

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Explanation of Plates XVI and XVII.

Plate XVI.—Stem of the waxberry, *Myrica cerifera*, with secondary roots upon which are formed the mycodomatia, or mycocecidia. Photograph by Mr. W. H. Walmsley.

Plate XVII, fig. 1.—Transverse section of a branch of a mycodomatia made below the middle showing large lacunar areas, magnified 25 diameters.

Fig. 2.—Cortex of mycodomatium showing large thick-walled unicellular hyphæ.

Fig. 3.—Meshed structure of finer hyphæ from mediocortex.

Fig. 4.—Coarser hyphæ at the base of a mycodomatial branch.

Fig. 5.—Older normal secondary root of the waxberry showing central woody cylinder, etc.

Fig. 6.—Finer hyphæ with one cell at *a* showing meshed structure suggestive of a collection of zooconidia. At *b* finer hyphæ are shown. Photographs by Mr. W. H. Walmsley.

HE MORPHOLOGY OF THE ROTATORIAN FAMILY FLOSCULARIIDÆ.

BY THOMAS H. MONTGOMERY, JR.[1]

thoughts which group themselves about the theories of larval gies, and in particular that one which regards the trochophore s the recurrence or at least parallelism of an ancestral phyletic omprise one of the many inducements to investigate the anat- the Rotatoria. For it is generally maintained by those workers hold the trochophore theory in its logical sequences, that the Rotatorian and the trochophore larva show close similarities. e of the approach, then, to test the correctness of the ideas of rval homologies, is to extend our knowledge of the structure of tatoria. A huge literature has grown up around this group of , but with the exception of a very few detailed monographs ers have contented themselves with the description of the exter- n. This is the more remarkable since the Rotatoria lend them- etter than most forms, thanks to their great transparency, to ly of fine details of structure in the living animal.

e who have not occupied themselves especially with the anatomy group make the common assumption that all Rotatoria show lly the same type of structure. But this is erroneous for two : first, because in Nature there do not occur types of structure, dations of structure; and second, because the Rotatoria evince eat differences among themselves. For the bearing of the group ole upon the views of larval homologies it is first necessary to e the various Rotatorian groups comparatively, in order to ne which of them is the most generalized or primitive; then up should be compared with the various kinds of trochophore This is a problem to be attacked from more sides than the morphological, for at once appears the striking fact that the ia are for the most part fresh-water forms, while the trocho- rvæ are characteristic exclusively of marine groups. Of the otatoria, are the most primitive forms found in the sea or in ter? And of them, are the pelagic forms more primitive than

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the creeping and attached forms? Here again we are met with the fact that a knowledge of distribution, and its factors, constitutes a very important ally in the study of phylogeny.

The present paper is offered as a contribution to the morphology of the Flosculariidæ alone. The only thorough account so far of the anatomy of any species of this family is that of Gast on *Apsilus lentiformis*. The occurrence of *Apsilus*, *Stephanoceros* and four species of *Floscularia* during the past winter and spring in a pond in the garden attached to our zoological laboratory, enabled me to study all these forms at the same time, and so to make the desired comparison of them. But until I have had opportunity to examine for myself other families of the group, it would be premature to express any opinions upon the phyletic value of the Rotatoria as a whole.

In regard to the methods of study, the examination of the living animals under slight pressure of the cover-glass has proved the most important. Fixation with hot corrosive sublimate or with Flemming's fluid, and staining with hæmatoxylin or carmines were of value in rendering nuclei more distinct, but even in life all the nuclei of the body tissues can be seen. The preparations may be mounted in balsam with no shrinkage by passing the objects from the absolute alcohol through graduated mixtures of cedar oil with alcohol. Sections were made of *Apsilus* alone. The complete literature has been cited for *Apsilus* and *Stephanoceros*, but for *Floscularia* only such contributions as concern the internal anatomy.

APSILUS, Meczn.

HISTORICAL.

Leidy (1857) described very briefly *Dictyophora* nov. gen. *vorax* nov. sp., from the vicinity of Philadelphia. Mecznikow (1866) described *Apsilus* nov. gen. *lentiformis* nov. sp., from Giessen; he noted the complete absence of ciliary wreaths, form of the corona, the lateral antennæ, intestinal tract, musculature, nephridia, and mistook for the brain a large muscle; he described the male also. Then Leidy (1882) figured his species, and mentioned that it differs from the species of Mecznikow in the lack of lateral antennæ and of a ganglion. Forbes (1882) gave a crude figure of and briefly described *Cupelopagis* nov. gen. *bucinedax* nov. spec., from Illinois, describing the alimentary tract and the external form. Foulke (1884) described as a new species *Apsilus bipera*, from Philadelphia; the corona was described as a membranous hood or net, two stomachs (the proventriculus erroneously regarded as a stomach), lateral antennæ, musculature; she pointed out that the

name *Dictyophora* is preoccupied, and proposed to recognize as three distinct species *Apsilus vorax* (Leidy), *A. bipera* Foulke and *A. bucinedax* (Forbes). In rejoinder to this paper Leidy, in the same year, proposed to unite these under the name *Apsilus vorax*, and found at last the lateral antennæ. Hudson and Gosse (1886) placed *vorax* and *bucinedax* as synonyms of *lentiformis*, and *bipera* as a distinct species; they relegated this genus to the *Floscularidæ*. Stokes (1896) gave a good description of *bucinedax*, from Trenton, N. J.; he described the lateral antennæ, œsophageal tube, long immobile setæ arranged in tufts upon elevations of the inner surface of the coronal cup, slender and numerous coronal muscles, an ovary extending across the whole width of the body. He also figures the corona of *bipera* from the same locality, and considers the four described species as all distinct. Lund (1899) held that the genus should be removed from the *Flosculariidæ*, and placed in a separate family near the *Asplanchnidæ*. Jennings (1900) figured the young of a species of *Apsilus*. Finally Gast (1900) has given a very detailed and accurate account of the anatomy and histology of a species he calls *vorax* Leidy (holding *lentiformis* to be synonymous), and regards *bipera* and *bucinedax* to be distinct from it.

Thus the European species, *lentiformis*, has been well described by Mecznikow and Gast, but of the three described American species the accounts, with the exception of that of Stokes of *bucinedax*, are so meager that the status of these is very perplexing. Foulke was right in uniting all these in the one genus *Apsilus*. *A. bucinedax* (Forbes) is well marked from all the others by the shape and great size of its germarium. Now the species which I shall describe is from the same locality as the forms described by Leidy and Foulke, and agrees with both of these in all essential particulars (these authors had overlooked the germaria, nephridia and foot, all the sense-organs except the lateral antennæ, and the œsophageal tube). Foulke considered her species to differ from Leidy's in possessing lateral antennæ (but these had been overlooked by Leidy), in ciliation of the corona (probably, as Gast has remarked, flame cells were mistaken for such ciliation), in more strongly developed muscular system, and in the external form. I am inclined to conclude that these differences are only apparent, due to the meagerness of Leidy's descriptions. Stokes stated that *bipera* differed from *vorax* in that the ventral margin of the corona is projected forward; but in the form described by me this margin shows considerable variations in form. Hence *bipera* (Foulke) had best be considered a synonym of *vorax* (Leidy); and the three clearly recognizable species may be distinguished as follows:

(*a*)—Germarium very large, extending across the whole width of the trunk, œsophageal tube present, immobile setæ within the coronal cup, ... *bucinedax* (Forbes).
(*b*)—Germarium small, rounded, no setæ within the corona.
 (1)—Œsophageal tube present, dorsal cuticula of trunk with transverse thickened ridges, ... *vorax* (Leidy).
 (2)—Œsophageal tube absent, dorsal cuticula without such ridges, *lentiformis* Mecznikow.

In the description which follows I shall refer for comparison mainly to the description of Gast for *lentiformis*, since his account is by far the most thorough.

ANATOMICAL.

The *external form* is fairly well known. The trunk is somewhat wider than high, rounded posteriorly, while anteriorly it is continued as a large corona (Rüssel, Mecznikow; cup, Leidy; net, Foulke; Mundtrichter, Gast). When fully extended the form is as shown in the figures (Pl. XVIII, 1–3), the corona very large and its aperture usually in the horizontal plane but sometimes oblique. The posterior wall of this aperture (mouth) may be rounded or notched, or may project forward as a convex lobe. On the ventral surface of the trunk is the rudimentary foot (Chitinring, Mecznikow; disk or sucker, Leidy; Fuss, Gast); and behind that, also ventral, the cloacal aperture. The lateral antennæ are clearly visible on the sides. The whole animal is so beautifully transparent that the greater part of the following description has been based upon a study of the living animal.

Hypodermis and *cuticula*.—The hypodermis is a very thin layer, with its flattened nuclei far apart; at the margins of the mouth it is only slightly thickened. The cuticula is thin, colorless, and (especially on the dorsal surface) covered with minute tubercles which may be ovoid or stellate (as Gast found). On the antero-dorsal surface of the trunk there are broad but narrow thickenings of the cuticula (Pl. XVIII, *x*, fig. 1), the number and exact arrangement of which is subject to considerable variation; each of these ridges bears tubercles. The cuticula and hypodermis of the body wall are continued inward as the lining of the corona; there the minute tubercles are replaced by minute conical projections, borne mainly upon longitudinal ridges of the cuticula. The whole cuticula is very flexible, and when the animal is strongly contracted and the corona rolled inward it is thrown into many folds; radial folds are also found around the cloacal aperture. No cilia are found anywhere upon the surface of the body nor within the corona, nor yet any immobile setæ.

Alimentary tract.—The large cavity (Pl. XVIII, *Inf.*, figs. 1–3) of he corona opens externally by the ventral mouth (coronal aperture). t is without cilia and lined by a continuation of the hypodermis and s cuticula. It is succeeded by a thick-walled short œsophagus Pl. XVIII, *Oes.*, fig. 1), also without cilia and with a sphincter muscle s Gast has described.) From the œsophagus, and attached to its osterior end, a narrow flexible tube (Pl. XVIII, *Oes.T.*, figs. 1–3) tends back into the proventriculus, which may be termed the œsophaal tube (this was also described by Stokes for *A. bucinedax*). This ibe is lined by a thin epithelium with a few nuclei, and its posterior ightly enlarged end is free; it is laterally compressed, and probably ssesses a musculature of its own, since it beats in rapid undulations ith many changes of form; it is very elastic to allow the passage of e large objects of food (mainly smaller free-swimming *Rotatoria*, also *stracoda*, *Nematoda*, *Infusoria* and *Acarina*). The proventriculus *Prov.*) is a large, distensible sac, of nearly the width of the trunk; its terior surface is lined by a cuticula without cilia, next follows a clear one of transparent protoplasm, then the peripheral cytoplasmic layer ontaining the nuclei. The musculature of this region described by ast I was unable to find. The mastax lies at the posterior end of the roventriculus; its appearance is shown in fig. 1, and the masticating eeth of one side shown in fig. 5; I have not been interested to determine its finer structure, which has been done very carefully by Gast, but will simply state that its large tooth is not sharply bent at the tip as in *entiformis*, and that of the four smaller teeth on each side one is frequently absent. Further, the usual parts may be distinguished: the unci and manubria, the fulcrum and its rami. On this follows the stomach proper (Chylusdarm, Mecznikow; œsophagus, Foulke; stomach, Leidy; Magendarm, Gast). This (Pl. XVIII, *Stom.*, figs. 1–3) is the only portion of the tract that is ciliated, and it is the assimilative portion of the intestine, with a single epithelium of large nucleated cells containing fatty globules. The posterior intestine (*P.Int.*) is a wide sac lined by a flat nucleated epithelium, which opens into the dorsal side of the cloaca (*Cl.*, figs. 2, 3), a distensible tube lined by a similar epithelium. The cloacal aperture (*Cl.Ap.*) is surrounded by a sphincter muscle (found by Gast) and is actually ventral, but morphoogically dorsal since it is behind the foot.

The only glands of the intestine are one pair of large stomach glands; these (*Stom.Gl.*, figs. 1–3) are pyriform with long ducts, the body of each gland placed at the ventro-posterior margin of the posterior intesine, the duct curving up around the dorsal margin of the intestine to

join the stomach; each gland (which has been fully described by Gast) has one large nucleus, or as many as three nuclei evidently produced by amitosis of the single one. The substance of these digestive glands appears granular.

Foot.—This has been carefully described by Gast, and I have little to add to his description. It is immovably attached to the surface on which the animal rests by the secretion of large hypodermal glands which are apparent only in the free-swimming stage. Its outline (*F.*, figs. 2, 3) is more or less circular and it is placed upon the ventral surface of the body anterior to the cloacal aperture, its margin slightly elevated.

Musculature.—*A. vorax* agrees very closely with *A. lentiformis* in the details of the musculature, which is very strongly developed. The following muscles may be distinguished (figs. 1–3):

I. Hypodermal muscles (muscles attached at both ends to the hypodermis).

(*a*) Circular muscles.

(1) Sphincter coronæ primus, *Sph.C. I.*, a completely closed ring at the edge of the corona with a dorsal loop (Gast's rm 1).

(2) Sphincter coronæ secundus, *Sph.C. II*, a narrower muscle just behind the preceding, interrupted ventrally (Gast's rm 2).

(3) Sphincter coronæ tertius, *Sph.C. III*, a completely closed ring (Gast's rm 3a).

(4) Sphincter coronæ quartus, *Sph.C. IV*, present only dorsally and not parallel to the other sphincters (Gast's mb of his fig. 2).

(5) Sphincter coronæ quintus, *Sph.C. V*, a slender muscle interrupted dorsally and ventrally (Gast described it as a branch of his rm 3).

(6) Sphincter coronæ sextus, *Sph.C. VI*, a completely closed ring (Gast's rm 4).

(7) Sphincter coronæ septimus, *Sph.C. VII*, the largest of the coronal sphincters, a closed ring giving on each side a branch to join the next (Gast's rm 5).

(8) Sphincter coronæ octavus, *Sph.C. VIII*, with a shorter dorsal and a larger ventral interruption (Gast's rm 6).

(9) Sphincter trunci primus, *Sph.tr. I*, a small muscle, present on each side dorso-laterally only, subject to considerable variation.

(10) Sphincter trunci secundus, *Sph.tr. II*, interrupted dorsally only (Gast's rm 7).

(11) Sphincter trunci tertius, *Sph.tr. III*, interrupted ventrally and dorsally (Gast's rm 8).

(12) Sphincter trunci quartus, *Sph.tr. IV*, interrupted dorsally but generally closed ventrally (Gast's rm 9).

(13) Sphincter trunci quintus, *Sph.tr., V*, dividing into three branches, interrupted dorsally and ventrally (Gast's rm 10).

(14) Sphincter trunci sextus, *Sph.tr. VI*, paired, latero-ventral on each side of the foot (Gast's mb 3).

(*b*) Longitudino-circular muscles.

(15) One pair, *L.-C.M.*, passing from the posterior end of the body to about the middle of the trunk, then each turns ventrad (Gast's dlm 3).

(*c*) Longitudinal muscles.

(16) Retractor coronæ primus, *R.c. I*, on the antero-dorsal surface of the corona (Gast's dlm 1).

(17) Retractor coronæ secundus, *R.c. II*, on the postero-dorsal surface of the corona (Gast's dlm 2).

(18) Retractor coronæ tertius, *R.c. III*, the innermost ventral pair, attached at the foot, passing forward and outward to insert upon *Sph.C. I* (Gast's vlm 1, but with a different anterior relation).

(19) Retractor coronæ quartus, *R.c. IV*, paired, ventral (Gast's vlm 2).

(20) Retractor coronæ quintus, *R.c. V*, inserted posteriorly at the sides of the foot, passing anteriorly to insert on *Sph.C. I* (it is much longer than Gast's vlm 3).

(21) Retractor coronæ sextus, *R.c. VI*, paired, each with two branches ending posteriorly on the sides of the trunk, a single anterior branch inserting on *Sph.C. I*, and with two small lateral branches (which for the sake of clearness are not shown on the lateral view of the animal). (This corresponds more or less to Gast's vlm 4.)

(22) Compressor trunci, *C.T.*, paired, subject to considerable variation in form, a very thin but broad muscle always with several branches, extending back to the sides of the foot and anteriorly inserting upon *R.c. III, R.c. IV, R.c. V.*

II. Visceral muscles (those which are entirely separated from the hypodermis, or in which only one end is attached to the hypodermis, which is the more usual condition).

(*a*) Circular muscles.

(23) Retractor mastacis, *r.m.*, paired, a short muscle connecting the side of the mastax with *L.-C.M.*

(24) Sphincter œsophagi, *sph.oes.* (found by Gast).

(25) Sphincter ani, *sph.an.* (found by Gast).

(*b*) Dorso-ventral muscles.

(26, 27) Depressor trunci primus et secundus, *d.tr.* 1 *and* 2, two pairs,

large muscles inserted on the hypodermis a little to one side of the foo passing dorsally through the body cavity and inserted with enlarg ends on the hypodermis on the sides of the proventriculus (Gast's dv and dv 2).

(28) Depressor trunci tertius, *d.tr.* 3, paired, smaller than the pı ceding and placed posterior to them (Gast's dv 3).

(29) Depressor trunci quartus, *d.tr.* 4, paired, behind the precedi (Gast's dv 4).

(*c*) Longitudinal muscles.

(30) Levator coronæ, *l.c.*, paired, inserted posteriorly on the hyı dermis at the sides of the mastax, passing through the brain in the w of the corona, subdividing anteriorly, and ending on *Sph.C.* 1, *G.* (Gas Lml 1).

(Gast's second visceral longitudinal muscle pair, his Llm 2, appeı in *vorax* to be hypodermal, namely my *R.C. V*).

(31) Deflexor coronæ, *d.c.*, paired, arising dorso-laterally by t branches on the hypodermis, and passing forward to insert upon *Sph. I* (Gast's Llm 3 and Llm 4).

(*d*) Irregular muscles.

(32) Contractor coronæ primus, *c.c.* 1, lying deep in the dorsal w of the corona, a muscle with four arms (this is the one considered Mecznikow to be a nerve ganglion; it corresponds to the mb of Gas fig. 1).

(33) Contractor coronæ secundus, *c.c.* 2, a muscle ring lying deep the dorsal wall of the corona behind the preceding, with three pairs lateral branches, and an unpaired medio-posterior branch (Gast's mb

Gast has described the histology of these carefully, and I ha nothing new to add to his description.

Nephridial system.—This (Pl. XVIII, figs. 2, 3, 6) consists of the po terior unpaired canal opening into the cloaca, the lateral canals, a the ductules, the latter terminating each in a flame cell. Mecznik and Stokes have described these organs fragmentarily, and Gast ve fully.

The posterior canal (Pl. XVIII, figs. 2, 3) which opens into the ant rior end of the cloaca (*Cl.*) is unpaired, thick-walled, with the lum spirally twisted. At its anterior end the lateral canals join together, that the terminal portion may be considered having originated by th fusion in the mid-line. Each lateral canal passes anteriorly, then ben dorsally (fig. 2), and has a very distinct lumen and a thin wall. Whe the lateral canal turns dorsally it greatly enlarges in diameter to form tripartite swelling; each of the three parts of this swelling possess

one nucleus, and each is a single large cell containing a much convoluted, somewhat pulsatile lumen. The dorsal termination of this swollen portion lies at the boundary of corona and trunk, and at that point joins with the common nephridial ductule. From this ductule a secondary ductule passes anteriorly for a short distance, then divides into three tertiary ductules (figs. 1, 2, 6). The most median of these bears the first flame cell (*Fl.C.* 1), and is connected with the corresponding ductule of the opposite side by a transverse commissure (fig. 1) placed above the mouth cavity. The middle tertiary ductule terminates in the second flame cell (*Fl.C.* 2). The most lateral tertiary ductule bends ventrad, then just behind the lateral antenna divides into two quartern ductules, the anterior of which is very short and terminates in the third flame cell (*Fl.C.* 3) placed near the lateral antenna, while the posterior passes backward and follows the course of the lateral canals of the nephridia, terminating in two short ductules each ending in a flame cell (*Fl.C.* 4, *Fl.C.* 5). Finally, from the common nephridial ductule pass backward on the dorsal surface of the trunk a pair of secondary ductules, each of which terminates in a flame cell near the mastax (*Fl.C.* 6). Gast's account differs in that he states that what I term flame cells 4 and 5 connect by short ductules directly with the lateral canals.

The nephridium of one side is thereby connected with that of the other at its anterior end by a commissure of the ductules, and at its posterior by fusion of the lateral canals. The only portion of the nephridia which are ciliated are the terminal flame cells; these (fig. 6) are completely closed from the body cavity, and each has an intracellular canal in which beats a long tuft of cilia (a typical "flame") attached at the wall of the cell where the lumen ends; the terminal end of each flame cell is somewhat enlarged, more or less amœboid, and contains one nucleus. The lumen of the ductules and of the lateral canals is also intracellular; a pair of nuclei are always present on the wall of the commissure connecting the anterior secondary ductules.

Germarium (Eierstock, Mecznikow; Keimdotterstock, Gast; ovary of Stokes) has the same relations as in *lentiformis*. It lies on the ventral side of the body (*Ov.*, figs. 2, 3) anterior to the foot, often in an irregular position due to the pressure of embryos upon it, a small rounded mass of cells, with a distinct cellular lining which is continued backward as the unpaired oviduct (*Ovd.*) and joins the cloaca between the openings of the nephridia and the posterior intestine. It contains yolk cells (nurse cells) to the number of 10–14, large cells without distinct boundaries, each with a large nucleus containing a huge nucleolus.

A much smaller space is occupied by the much smaller germ cells, placed near the duct, characterized by very small, deep-staining nuclei and clear cytoplasm. Gast correctly noted these two kinds of cells and their differences. The egg cells do not reach their full size within the germarium, but only when they leave it and reach the oviduct, which becomes dilated by them to serve as a uterus for the complete embryonal development; as many as five large embryos are found in the uterus at one time, representing different stages of development.

Nervous system.—Stokes was the only one to see this organ complex before the time of the very thorough account by Gast. The cerebral ganglion lies in the mid-line above the alimentary tract (Pl. XVIII, *Cer.*, figs. 1, 2), at the junction of corona and trunk or a little anterior to this point. Seen from the side (fig. 2) it appears ovoid, a little longer than high. Seen from above (*Cer.*, figs. 1, 6) it is found to be widest in the transverse plane. Through each side of it passes a visceral longitudinal muscle (levator coronæ, *l.c.*). In life as well as in stained preparations the following nerves can be seen passing from this cerebral ganglion (figs. 1, 6). From its dorso-anterior edge three pairs of delicate nerves, which converge to the dorsal sense-organ (*D.Sens.O.*), *i.e.*, pass upward and forward from the ganglion. Each of these nerves has a nucleus at the point where it joins the ganglion. From each side pass out at least eight nerves: one for the latero-anterior sense-organ (*A.Sens.O*); one for the latero-posterior sense-organ (*L.Sens.O.*); two large nerves which pass back from the latero-posterior angle of the ganglion but which could be traced only a short distance; and four other nerves which could be traced only a short distance, but one or two of which appeared to be connected with the nephridial tubules. The ganglion and its nerves are thus strictly bilaterally symmetrical.

Now the three pairs of nerves which can be traced to the three sets of sense-organs all arise from the dorsal margins of the ganglion; the dorsal portion of the ganglion may then be essentially sensory. The two large ventral posterior nerve pairs arise from two large cells, each evidently bipolar, placed at the ventro-posterior margin of the ganglion; Gast noted only one of these and only one posterior nerve. These two cells are characterized by their great size (they might be called on this account neurochord cells, with reference to similar huge cells in *Nemertini*, *Annelida* and *Crustacea*), and the large size of their nuclei. Since these differ so markedly from the demonstrated sensory nerves, it is very probable that they innervate either the musculature or the viscera, *i.e.*, that they are either motor or splanchnic in function. Then since their roots are ventral in the ganglion, it would follow that

there may be a differentiation within the latter of a dorsal sensory and a motor or sphlanchnic ventral portion. The nerve cells in the brain are quite numerous and symmetrically arranged, but cell boundaries are distinguishable only in the case of the two huge cells. Two consecutive sections of one and the same ganglion are figured (figs. 7, 8), cut in an obliquely horizontal plane, one passing through the nerves to the lateral antennæ and one of the huge cells (fig. 8), and the other (fig. 7) passing further forward. In the latter can be seen what appears to be a transverse fibrous commissure on the ventral surface of the ganglion. The nerve cells are thus arranged mainly dorsally and posteriorly.

There are no recognizable nerve cells on the ventral surface of the alimentary tract, as far as can be determined by the usual staining methods.

Sense-organs.—The dorsal sense-organ (*D.Sens.O.*, figs. 2, 6) is a specialization of the hypodermis on the dorso-midline of the corona, and was discovered by Gast. It consists of a group of cells (fig. 6) in which one large and five small nuclei can be seen, which compose a thickened area of the hypodermis, and above which there is a small annular thickening of the cuticula; no sense hairs were seen. The antero-lateral sense-organs, also discovered by Gast, lie each (*A.Sens.O.*, figs. 1, 6) upon the side of the corona, as a thickening of its wall. Each consists of a cytoplasmic mass containing four large nuclei immediately imbedded in a more granular cytoplasm, while into a more hyaline cytoplasm extends a slender cylindrical rod from the cuticula; there are thus some differences from the relations in *lentiformis*. A single nerve, containing a nucleus at its junction with the cerebral ganglion, innervates each of these organs. The postero-lateral sense-organs (lateral antennæ) lie each on the side of the corona somewhat ventral near the junction of the trunk (*L.Sens.O.*, figs. 1–3). To each passes one large nerve, with a large nucleus at its peripheral end; and as Gast also observed, the organ itself consists of a tubercular elevation of the body wall, and on the apex of this a cylindrical cuticular process, bearing a tuft of long, non-vibratile sense hairs (fig. 6); the base of the cuticular process is enlarged and extends below the hypodermis.

Body cavity, connective tissues.—The body cavity contains a clear fluid in which float masses, varying in number and size, of a brown color; these are non-cellular and probably represent bye-products of metabolism. The connective tissue elements are branched, naked cells with many processes, constantly changing their form and moving about through the body cavity. They are frequently found in close

connection with the walls of the nephridia, particularly with the anterior commissure.

The immature female.—The free-swimming female (fig. 4), just hatched from the egg, shows the following differences from the adult. The corona is represented simply by a circular hypodermal thickening bearing a row of vibratile cilia; and in the part of the trunk projecting anteriorly beyond this ring lie a pair of large red eyes (*E.*). The mouth (*M.*) is ventral, and the most anterior portion of the alimentary tract contains short cilia which do not extend out of the mouth aperture. The cerebral ganglion (*Cer.*) is much larger than in the adult. The whole hypodermis is thicker, and that portion of it lining the well-demarcated foot (*F.*) consists of about six huge cells (*F.Gl.*) which Gast has shown to be gland cells, by the secretion of which the animal firmly attaches itself. The surface of the foot disk is covered with long cilia. The musculature I have not drawn in this figure, but it is similar to that of the adult.

STEPHANOCEROS, Ehrb.

Historical.

Stephanoceros was discovered in 1761 by Eichhorn, and he later figured it (1775, according to Ehrenberg). O. F. Müller (1776) declared it to be a Tubularian, and Oken (1815) also placed it among the hydroids. Goldfuss (1820) first named it, calling it *Coronella fimbriata*. Since this generic term was preoccupied Ehrenberg (1832) changed it to *Stephanoceros*, and called the species *Stephanoceros Eichhornii*, which all later writers have followed. According to our present generally accepted rules of nomenclature, however, and in justice to Goldfuss, this species must be named *S. fimbriatus* (Goldfuss) and not *S. eichhornii* Ehrenb. Ehrenberg (1832, 1835, 1838) gave good figures of the animal, described the intestine, stomach glands (which all later writers seem to have overlooked), six longitudinal muscles, the ovary, and the flame cells (which he termed gills). Perty (1852) described as a new species *S. glacialis*, but this is generally held to be an abnormal individual of *fimbriatus*. Leydig (1854) added richly to the knowledge of its anatomy and development. He was the first to note the nucleated hypodermis, circular muscles (he stated there are four longitudinal muscles in the foot which divide dichotomously), the œsophageal tube, cilia in the coronal cup and intestine, lateral canals of the nephridia (with Ehrenberg he regarded these organs as respiratory). Gosse (1855) described minutely the mastax, and in 1862 gave quite a full account of the structure; by experiment he proved the nephridia to be

and not respiratory, found the contractile vesicle, four flame ach side of the body, described the dorsal glandular mass Leydig) as the brain, and described five pairs of longitudinal Cubitt (1870) found the lateral sense-organs, but made the ror of supposing that each of them was connected with a (his pulsatile sac), and supposed them to be respiratory for taking water into the nephridial tubules; he carefully the ciliary wreath within the coronal cup, but mistook (like id most of the later describers) the dorsal glandular body for

Hudson and Gosse (1886) gave very good figures; found five on each side of the body, described the connection of the lateral h the contractile vacuole, discovered the dorsal sense-organ, ibed six pairs of longitudinal muscles. Vallentin studied ections; he found that large hypodermal cells of the foot e tube; that the dorsal mass is not nervous but glandular and a duct into the vestibule; he regarded the large hypodermal e bases of the arms to be nerve cells. The male of this species described by Western (1893) and more carefully by Dixon-1896). Less important are the papers of Dujardin (1841), 845), Dobie (1854), Pritchard (1861), Cubitt (1869), Peirce osseter (1881, 1884), Lord (1885), Jennings (1894, 1896, 1900, ic).

ANATOMICAL.

g new can be added to our knowledge of the *external form* ., fig. 16). The margin of the corona is prolonged into five s, which are slightly flattened and extensile. These arms are urved, and the dorsal, unpaired one slightly longer than the The body is long and slender, rather strongly demarcated long foot which ends in a short peduncle (fig. 14). The gelabe (*Tub.*) is very transparent, with annular folds, elastic and thickness.

rmis.—The hypodermis (*Hyp.*, figs. 9–11) of the trunk is a r with flattened nuclei. At the margin of the corona it is ckened, so as to form at the base of each of the arms a mass of e large rounded nucleated cells. The hypodermis of the arms s thick as that of the trunk, but neither in the living state nor parations in which the nuclei of other regions of the hypodertained very sharply are nuclei to be found in it. The hypothe arms of the corona would therefore appear to be a direct ion of the cytoplasm of the large hypodermal cells at the

base of the arms. Each of these cells then has a great extent, from its base to the free tip of an arm. When the arms are fully extended the outlines of the hypodermis seen on optical section appear even, without any irregularities. But when the arms are partially retracted, the hypodermis appears partitioned into circular areas on its inner surface; on surface view these are seen as in fig. 13; and on optical section as in fig. 12. At first I was inclined to consider these as representing component small cells of the hypodermis, but the absence of nuclei in them excludes that view and they can be regarded only as folds of the continuous hypodermis due to the contraction of the arm. The arrangement of the cilia upon the arms is very complicated and has not yet been satisfactorily determined; it is best seen on a living arm in a contracted condition. On the outer as well as upon the inner surface of each arm the arrangement of the cilia is shown by the dotted lines in fig. 12; there the cilia are arranged in single rows, making angles together, these single lines of cilia separated by spaces which are without cilia. But on lateral view each arm shows a different arrangement of the cilia; here (fig. 13) the cilia are arranged in tufts placed on oblique thickenings of the surface of the hypodermis. In this figure only those cilia seen in profile are drawn *in extenso*, while the insertion points of those on the aspect of the arm toward the observer are represented by stippling, each patch of fine dots denoting a tuft of cilia. At the tips of the arms the cilia are more evenly arranged along the whole hypodermis. The appearance of the tufts of cilia, arranged in oblique bands, are shown for the two ventral arms under a lower scale of magnification in fig. 16. The cilia are extensile, and in fully expanded condition attain a length considerably greater than that of the arms themselves; but this is to be seen generally only when the animal is under the pressure of a cover-glass. I could not determine the presence of a cuticula upon the arms.

The hypodermis of the foot is thickened, and at the junction of this region with the trunk (figs. 9, 10) certain cells are very prominent. These may correspond to the foot glands of the other *Rotatoria*, and secrete the substance of the tube in which the animal lives. The short peduncle (fig. 14) by which the foot is attached probably represents a secretion of hypodermal cells at the distal end; this peduncle is short, hard and homogeneous.

Alimentary tract.—By an oblique diaphragm (*Dia.*, figs. 9, 10) the cavity of the corona is divided into a more spacious infundibulum (*Inf.*) and a more posterior vestibulum (*Vest.*), both of which have a nucleated lining similar to that composing the hypodermis. The diaphragm is

an annular fold composed of a more thickened cell layer; it is shown in oblique ventral view in fig. 11, on lateral view in fig. 9, and on dorsal view in fig. 10. The drawings show that this ring fold bears cilia along the anterior border of its ventral half, a tuft of longer cilia on each side, while the margin of its dorsal half has no cilia. Only this diaphragm bears cilia, and none are found upon the walls of the infundibulum and vestibulum.

By a narrow aperture there follows upon the vestibulum the œsophageal tube (*Oes. T.*), the distal end of which projects freely without attachment into the cavity of the proventriculus. This is an elastic tube that beats rapidly in many dilations and therefore probably possesses a musculature of its own; I could not determine nuclei in its wall. The proventriculus (*Prov.*) is the largest portion of the alimentary tract, its wall composed of a single epithelium of large cells with distinct nuclei, and lined internally by a cuticula. In this posterior part lies the mastax, concerning which it will suffice to refer to fig. 18, a dorso-posterior view. Gosse was wrong in considering it to be rudimentary, for it has well developed unci and manubria, fulcrum and rami. The stomach (*Stom.*) is a rounded, dorsally placed sac lined by large cells which bear numerous long cilia. The posterior intestine (*P.Int.*) follows, lined by a flattened epithelium without cilia and with distinct nuclei; and behind it a very short rectum opening into the cloaca (*Cl.*).

A single pair of large stomach glands (*Stom.Gl.*, figs. 9, 10) are present, each latero-ventral at the junction of proventriculus and foot, and each containing several nuclei.

Musculature.—The following longitudinal visceral muscles run from the foot through the body cavity of the trunk to attach themselves to the bases of the arms of the corona (figs. 9–11). One pair to the dorsal arm, extending to its outer sphincter muscle. A pair of dorso-lateral muscles, each of which inserts anteriorly on the thickened hypodermal ring of the corona at the junction of the dorsal with a lateral arm. And a pair of ventro-lateral muscles, each of which, when reaching the thickened hypodermal ring of the corona, divides into two branches which pass forward to the outer sphincter muscle of the coronal arms. Thus I find only three pairs of longitudinal muscles. All these muscles have their muscle bodies with nuclei contained in the foot. Of the circular hypodermal musculature, there are a large number of delicate sphincters in the foot and trunk region, and at the anterior end of the corona two sphincter muscles of large size (*Sph.C. I* and *II*, figs. 9–11). The remaining complicated network of musculature of the corona I have not studied.

Nephridial system.—The whole nephridial system of one side of the body is shown in fig. 9, and a portion of it from dorsal view in fig. 10. Into the posterior end of the cloaca (*Cl.*)opens the unpaired contractile vacuole (*Con.V.*); and into this a long elongate unpaired sac with distinct outer lining and containing a convoluted tube with wide, pulsatile lumen, the common terminal canal. At the free end of the latter unite with it the two longitudinal canals of the nephridia. Each of these passes forward latero-ventrally to about the level of the stomach glands, and there becomes much convoluted so that the exact course is difficult to follow; but through all these convolutions it remains a single tube with distinct walls. Each lateral canal then turns dorsad to about the position of the cerebral ganglion where it again becomes convoluted; its diameter is greatest in this portion of its course. At this anterior end the ductules are given off to the flame cells, and, as fig. 9 shows, one ductule passes forward and divides into five ductules, each ending in a flame cell (*Fl.C.* 1, *Fl.C.* 2). A second ductule passes posteriorly and ends in a flame cell (*Fl.C.* 6) placed near the stomach. In one individual I saw two other flame cells (*Fl.C.* 7, *Fl.C.* 8) placed near the sixth flame cell, but their connections with the ductules of the nephridial system I did not find. As the dorsal view, fig. 10, shows, in front of the cerebral ganglion a transverse commissure connects the ductules of the two sides of the body. Each flame cell (fig. 15) bears internally a flame of long cilia, and appears completely closed from the body cavity. The lumen of all the ductules and the main canals is intracellular, and cilia are found only in the flame cells. The whole nephridial system is exceedingly distinct in life, provided the animal is well expanded.

Dorsal glandular organ.—On the dorsal side, at the junction of the corona with the trunk, lies a large mass (*D.Gl.*, figs. 9, 10) of clear vacuolar structures, which has been heretofore regarded by most writers as the brain. It is composed of clear transparent globules, varies in size in different individuals, and becomes shrunken by the action of alcohol. Nuclei are to be seen at its margins, particularly posteriorly, but I was unable to determine whether each of its component globules represents a cell. This organ is closely attached to the dorsal hypodermis around the dorsal sense-organ (*D.Sens.O.*, fig. 9), and is penetrated by the nerves which pass to the latter from the cerebral ganglion (*Cer.*); it has no connection with the alimentary tract. The functional significance of this organ is wholly obscure, and I have supposed it to be glandular simply on account of its connection with the hypodermis and the dorsal sense-organ. It is not

probable that it forms the secretion for the tube, since it is of very large size in those large individuals with fully-formed tubes.

Germarium, oviduct.—The germarium (*Ov.*, figs. 9, 10) is a more or less spherical organ placed on the ventral side of the body, composed of a syncytium (fig. 17) containing fully fifteen large nuclei which are nurse cells (yolk cells), and with at one end much smaller nuclei (ovogonia). The whole is surrounded by a nucleated membrane which is continued as a thin-walled unpaired oviduct (*Ovd.*) to open into the ventral surface of the cloaca between the rectal and the nephridial openings. One ovum matures at a time within the germarium, then is discharged into the oviduct which serves as a uterus for its further development until it reaches the free-swimming stage. As many as four or five embryos are to be found at once in the uterus.

Nervous system.—Most of the preceding writers have mistaken the dorsal glandular body for the ganglion, while Vallentin recognized this body as glandular, but supposed it to open by a duct into the alimentary canal, and considered the large hypodermal cells at the bases of the arms to be nerve cells. The cerebral ganglion (*Cer.*, figs. 9, 10) lies directly below the dorsal glandular mass, is elongate from side to side and approximately cylindrical on lateral view. On stained preparations I could determine that it is composed of many small nerve cells, the nuclei of which stain deeply. On lateral view of the expanded living animal (fig. 9) the following nerves are seen to arise from it: (1) One pair which passes directly dorsad or dorso-caudad to innervate the dorsal sense-organ (*D.Sens.O.*); this pair penetrates the dorsal glandular body, and probably represents what Vallentin mistook for a glandular duct leading into the vestibulum. (2) A pair of nerves to each lateral sense-organ (*L.Sens.O.*). (3) An unpaired, very delicate median nerve to the dorsal hypodermis behind the dorsal sense-organ. (4) A pair of nerves which pass backward upon the sides of the proventriculus (*Prov.*). And (5) a pair of nerves, the largest of all, which pass ventrad on the sides of the proventriculus. I have found no evidence that the large hypodermal cells at the bases of the arms are nervous; the long fibres which Vallentin found proceeding from them probably represent the continuations of these cells to form the walls of the arms.

Sense-organs.—Eyes were seen only in one individual, a pair of small red spots (*E.*, fig. 9), lying close to the cerebral ganglion. The dorsal sense-organ (*D.Sens.O.*, figs. 9, 10) is a slight thickening of the hypodermis bearing a tuft of short sense hairs, which penetrate a circular aperture of the cuticula. Each lateral sense-organ (*L.Sens.O.*) has

one conspicuous large nucleus, and likewise bears a tuft of short cilia.

The body cavity is voluminous in the trunk and the foot (but does not continue into the peduncle of the latter). In it are free-floating, non-cellular corpuscles, probably waste products. The cavity of the arms is continuous with that of the trunk (figs. 9–11). Very few connective tissue cells are present in the body cavity.

FLOSCULARIA, Oken.

HISTORICAL.

Of the numerous writers upon this genus only the following have considered to any extent the internal anatomy: Ehrenberg (1834, 1838) wrote with all the enthusiasm of the naturalist: "Sie sind einzeln, wie seltene schöne Blumen auf einer Wiese, und erfreuen gleich ihnen das Auge des Beobachters." He found the mastax, œsophageal tube and the stomach glands. Dobie (1849) gave a careful description with good figures, and distinguished the infundibulum, vestibulum and proventriculus; he saw the cilia on the diaphragm. Leydig (1854) added to this description in finding the contractile vacuole and the longitudinal muscles. Gosse (1855) described in some detail the masticatory apparatus; and (1862) erroneously termed a vascular system the narrow spaces of the body cavity in which float excretory corpuscles. The account of Moxon (1864) is much more thorough than any of the preceding, and contains the discovery of the dorsal and lateral antennæ, correct position of the cilia within the infundibulum, and occurrence of the nephridia with four flame cells on each side of the body. Cubitt (1869) studied particularly the cilia within the coronal cup. The papers of Grenacher (1869) and Cubitt (1872) added little new. Eckstein (1884) gave a careful account of the hypodermis, and the muscles and peduncle of the foot. Hudson and Gosse (1886) add but little to the account of Moxon. The paper by Hood (1895) I have not seen. The males have been described by Hudson and Gosse and by Weber (1888). But the best of these descriptions, those of Dobie and Moxon, leave much untouched in regard to the finer anatomy.

ANATOMICAL.

F. campanulata Dobie (Pl. XX, figs. 27–35; Pl. XXI) was the species obtained in the greatest numbers, and on this account its anatomy could be more fully determined than that of the others. *F. conklini* Montg. (figs. 25, 26, Pl. XX) was obtained at the same time, but it is rather a difficult form to investigate on account of the large number

of minute floating corpuscles within the body cavity which greatly obscure the internal organs. *F. coronetta* Cubitt (Pl. XX, figs. 22–24) and *F. ambigua* Hudson (Pl. XIX, figs. 19–21) were the other species studied, but *ambigua* in only a few individuals, so that for this species my observations are unfortunately fragmentary.

General form.—In all Flosculariansthere may be distinguished the corona, trunk and foot (Pl. XXI, fig. 37). The corona is in anterior extension and enlargement of the trunk. In *campanulata* (Pl. XX, figs. 27, 28, 31) it is largest, widely bell-shaped and prolonged into five broad lobes, the dorsal of which is largest and longest, next the two ventral lobes, and smaller than these the two lateral lobes. In this species the corona is subject to considerable individual variations in form, but is always much wider and fully as long as the trunk. In *ambigua* (Pl. XIX, fig. 20) the corona is relatively smaller, and of its five lobes the lateral pair are usually very small and often distinguishable only by the cilia which they bear. In *conklini* (Pl. XX, figs. 25, 26) the corona is more cylindrical, frequently considerably less than half the length of the trunk, the lateral lobes also very small. In *coronetta* (Pl. XX, figs. 22, 23) the lobes are more cylindrical and narrowed, with enlarged (knobbed) tips, the dorsal one only slightly longer than the others.

The trunk is elongate and cylindrical, in *conklini* (fig. 25) more arched on the ventral than on the dorsal side. The foot is an elongate proximal extension of the body, relatively longest in *conklini* and *coronetta*. The foot ends in a peduncle by which the animal is firmly attached to the surface of a water plant stem. This peduncle is much longer than broad in *campanulata* (Pl. XXI, fig. 40) and *ambigua*, little longer than broad in *coronetta* (Pl. XX, fig. 24), and fully as broad as long in *conklini* (fig. 26). These different species were all found attached to *Myriophyllum*, but to different parts of it, *campanulata* always to the very finest outgrowths of the plant; *conklini* usually to the angles at the bases of stems; *ambigua* and *coronetta* to larger stems.

In all these forms the animal is surrounded by a gelatinous, elastic tube (Pl. XXI, fig. 37, *Tub.*), with an anterior opening; in *conklini* (Pl. XX, fig. 26) the tube is relatively largest and its outer surface often covered with foreign particles, and in *campanulata* it is exceedingly transparent and usually without any such adherent particles. By a weak solution of methylene blue the tube quickly becomes colored intensely; and this method of demonstrating it shows its form with great distinctness.

The animals are highly contractile, thanks to the strongly developed

longitudinal muscles; the coronal lobes may be folded into the infundibulum, the whole corona and trunk much shortened, and the foot so contracted that its peduncle is brought close to the trunk.

Hypodermis.—The hypodermis of the trunk is a thin, one-layered epithelium, with relatively few nuclei (*Hyp.*, figs. 20, 22, 23, 25, 27, 28). It bears a hyaline, structureless cuticula (*Cut.*). On the free margin of the corona it is much thickened and contains large nuclei which are easily seen even in life. In *campanulata* (Pl. XX, figs. 27, 28) this coronal thickening follows the margin of each lobe, and at the tips of the dorsal and ventral lobes are particularly large nuclei. That is also the case with *ambigua* (Pl. XIX, fig. 20). In *conklini* (Pl. XX, fig. 25) the dorsal lobe has the hypodermis thickened only at its tip. In *coronetta* (figs. 22, 23) the hypodermal thickening forms a ring around the base of the lobes, while the hypodermis forming the walls of the lobes is but little thicker than that of the trunk; this is an approach to the condition in *Stephanoceros*, and will probably be found to be the case in all forms where the lobes are slender. Another peculiarity of *coronetta* is that the cuticula covering the lobes is thicker than elsewhere upon the body; in the other species I could not distinguish with certainty a cuticula upon the lobes, though probably a delicate one is present.

The cilia of the external surface are limited in the adult to the margins and lobes of the corona. In *conklini* (figs. 25, 26) these cilia are no longer than the corona, and strongly vibratile; they are found also only upon the tips of the lobes. In *coronetta* the tip of each coronal lobe bears a tuft of long cilia (fully as long as the trunk), which have a slow undulatory movement; while the sides of the lobes and the interlobular margin of the corona bears much shorter cilia with a more rapid movement. In *campanulata* (Pl. XXI, fig. 37) the cilia fringe the whole free margin of the corona. Here they are longest upon the tips of the lobes, but all have a length greater than that of the corona and trunk together, and sometimes nearly two-thirds that of the entire animal. The cilia in this species are non-vibratile, or at most with slight undulatory movements, and toward their free ends become gradually exceedingly tenuous. All preceding authors have figured them much too short, probably because their full length can be determined only with high powers of magnification. These cilia are less like true cilia than like the tenuous, stiff pseudopodia of *Heliozoa;* and like the latter they are extensile and retractile to some degree at least, as is shown by a protoplasmic flowing. They serve not to obtain food particles by ciliary currents, but rather as a wide basket to encompass the

Generally they are held stiff and rigid; but at times wave-like lations are seen to pass slowly along them. Unlike a heliozoan lopodium there is no supporting axial filament within them. *gua* has cilia like those of *campanulata*, and also fringing the ; coronal margin. In these two species and in *coronetta* the cilia ct out of the anterior end of the body in a thick tuft when the al is strongly contracted.

the foot the hypodermis is thicker than in the trunk, composed ger cells. Its cells are largest at the junction of the trunk with ot (Pl. XIX, fig. 20; Pl. XX, 22, 23, 25, 27, 28); and these may ınd cells which produce the gelatinous tube. The peduncle (figs.)) is homogeneous without cells or nuclei; it probably represents etion of certain large hypodermal cells found in the embryo but t in the adult, which are placed at the distal end of the foot (Pl. fig. 38). The peduncle is firmly attached to the plant stem, so ly that when the animal is torn loose from its tube the peduncle en left still attached.

mentary tract.—The following regions are marked in all the forms: libulum, vestibulum, œsophageal tube, proventriculus, stomach, rior intestine, rectum, cloaca.

; infundibulum (*Inf.*, figs. 20, 22, 25, 28) is the cavity of the ante- ortion of the corona, and its opening to the exterior constitutes oad mouth. It is lined by a thin one-layered epithelium in which i can be distinguished by staining, is without cilia, and its wall arated from the hypodermis to which it is attached only at its ior margins, by the body cavity. The infundibulum is partially led off from the vestibulum behind it by the diaphragm. This , figs. 22, 23, 25, 27, 28) is a thickened annular fold of the internal f the alimentary tract, and the only portion of the latter anterior ; stomach which is ciliated. Viewed from in front, *i.e.*, from the h opening, it appears circular with a knob-like thickening at each n *campanulata* (fig. 31). Each of these knobs bears a tuft of long lowly vibratile cilia, while the border of the diaphragm ventral to knobs bears a semicircle of very short and delicate, rapidly tile cilia. There are no cilia dorsal to the knobs. In *conklini* 25) the relations are in general similar. In *coronetta* (figs. 22, 23) orsal free margin of the diaphragm is considerably thicker, and short pointed projections (like those within the infundibulum *silus*); while the ventral margin bears rather long cilia upon sev- nobs. In all these species (I did not determine the relations in *gua*) the cilia appear usually to beat forward, *i.e.*, into the in-

fundibulum, but frequently they point backward and beat in the vestibulum. The latter (*Vest.*, figs. 20, 22, 23, 25, 27, 28) is the portion of the alimentary tract placed at the base of the corona, at the junction with the trunk; its lining is like that of the infundibulum.

Attached to the narrowed posterior aperture of the vestibulum is a slender tube, the œsophageal tube, (*Oes.T.*, figs. 20, 22, 23, 25, 27, 28), which extends back without posterior attachment into the proventriculus. This tube is very thin-walled, and constantly moves in rapid undulations and distortions, so that its shape can be made out only when it comes to rest. Nuclei could not be determined in its walls in life, and all fixatives preserve it as poorly as they do the nephridia; so that stained preparations did not help in understanding its structure. But very delicate spirally arranged muscle fibrils compose a part of its wall; and it is probable that it possesses a nerve center of its own, since it continues to beat after the other organs have ceased to live. In a state of rest (figs. 34, 35) it is cylindrical with a posterior enlargement, and a very small posterior aperture into the proventriculus. It is very elastic to allow the passage of large objects of food (*Infusoria* and *Mastigophora* in the species studied), and may sometimes be everted anteriorly into the vestibulum.

The proventriculus (*Prov.*, figs. 20, 22, 23, 25, 27, 28) is a large sac lined by a rather thick epithelium, with readily distinguishable nuclei; its internal surface is bounded by a delicate cuticula. At its posterior end lies the mastax (*Mast.*). This consists of chitinous, jointed parts, the manducatory apparatus, and of musculature for their movement. Gosse (1855) holds that *Stephanoceros* and *Floscularia* have no mastax in the sense that this term is used for other *Rotatoria*, *i.e.*, that in the *Flosculariidæ* it is not a special portion of the alimentary tract with a lining of its own. But it is surely homologous with that of the other groups, and though relatively very small I find it is not rudimentary but possesses all the characteristic parts found in the other *Rotatoria*. Thus in *campanulata* (Pl. XXI, fig. 39) the manubrium consists of two teeth, together constituting the uncus (*Un.*), and of a basal piece, the manubrium (*Man.*). A broad chitinous plate belonging also to the malleus lies below the uncus. The incus consists of a median fulcrum (*Ful.*) and of lateral rami (*Ram.*). The musculature is difficult to determine in its exact arrangement, so that I have not drawn it, but is readily seen in the living animal. The organ then has a special lining, the musculature, and is truly a mastax in the sense of Gosse, even though it does not form a separate compartment of the alimentary tract; and this is the case also in *Stephanoceros* and *Apsilus*.

The stomach (*Stom.*, figs. 20, 22, 25, 27, 28) is thick-walled, with large cubical cells bearing long cilia; this is the assimilative portion of the intestine, and its cells are more or less filled with globules. Upon it follows the posterior intestine (*P.Int.*), lined by a thin-walled, nucleated epithelium without cilia. Here the fæces form large food balls in *ambigua*, but not in the other species. By a short rectum (*Rec.*), often barely distinguishable from the posterior intestine, an opening into the cloaca (*Cl.*) is attained. The cloaca is ciliated apparently only in *coronetta* (figs. 22, 23), is very thin-walled, and opens to the exterior by the cloacal aperture placed dorsally at the junction of the trunk and the foot, or a little anterior to it. The diameter of the different portions of the alimentary tract is dependent upon the amount of food contained in them.

One pair of stomach glands (*Stom.Gl.*, figs. 20, 22, 23, 25, 28) is present in all the species, placed latero-ventrally at the boundary of stomach and proventriculus. In *coronetta* (figs. 22, 23) and *ambigua* (fig. 20) each gland is elongate with a single large nucleus, in *conklini* (fig. 25) pyriform with several nuclei, in *campanulata* (fig. 28) of the same shape but with one nucleus. The connection of these glands with the stomach was determined positively only for *ambigua*, but there can be doubt that they discharge into the stomach and not into the proventriculus in the other forms also.

A peculiar structure was found in every individual of *ambigua*, but in none of the other species. This was a body of a brown color (*X.Y.*, fig. 20) placed in the posterior intestine, with a thick wall, a deep-staining body (nucleus ?) in this wall, and rather vacuolar contents. It appeared to lie within the posterior intestine. It can hardly be a parasite, since exactly one of these bodies was found in the same region in each individual.

Musculature.—An exhaustive study of the musculature, such as was given for *Apsilus*, was not attempted for *Floscularia*. Of the hypodermal musculature (the following description applies particularly to *campanulata*) a number of delicate transverse muscles are present around the foot and trunk (fig. 27); by their contraction these portions of the body are compressed, and the body fluid driven forward to unfold the corona. In the corona this musculature is richly developed (figs. 27, 28), though the separate muscles are fine. Two sphincter muscles are present here, one close to the coronal margin and another behind it. Numerous slender longitudinal muscles connect these together and with the hyopdermal thickening. The diaphragm has its own sphincter, and receives branches of the lateral and ventral longi-

tudinal trunk muscles; while the walls of the vestibulum have a rich network of muscles. There are three pairs of large visceral longitudinal muscles (figs. 22, 23, 25, 27, 28), a pair of dorsal (*D.M.*), of lateral (*L.M.*) and of ventral (*V.M.*) muscles respectively, attached anteriorly to the coronal margin, passing the whole of the trunk and in the foot converging together to form a muscle band which extends posteriorly as far as the proximal end of the peduncle (fig. 40); the cell bodies (*Musc.C.*, fig. 28), and nuclei of these large muscle cells are placed within the foot. Probably the proventriculus has its proper musculature, thought it could not be determined; and the muscles of the œsophageal tube have been already mentioned.

Nephridial system.—This is essentially the same in *conklini* (fig. 25), *campanulata* (28, 30, 41) and *coronetta* (figs. 22, 23). Opening into the posterior end of the cloaca is an unpaired, thin-walled contractile vesicle (*Con.V.*), and into this an unpaired contorted canal enclosed by a membrane. From the proximal end of this canal pass forward the two longitudinal canals, one on each side of the trunk, a little more ventral than dorsal in position. The anterior portion of each of these canals becomes convoluted, and this convoluted portion is thicker than the rest of the duct with a narrower lumen, and somewhat contractile. It is only by continued study of compressed living individuals that the bendings and interlacings of these very transparent canals can be determined. Anteriorly each longitudinal canal gives off an anterior and a posterior ductule. Each anterior ductule divides close to the lateral wall of the corona into three secondary ductules, each terminating in a single flame cell (*Fl.C.*). The posterior ductule passes caudad to about the region of the œsophageal tube on the side of the body, then divides into two secondary ductules, a shorter dorsal one ending in a flame cell on the side of the mastax, and a longer ventral branch terminating in another flame cell on the latero-ventral aspect of the trunk. In *conklini* I could not ascertain the mode of union of the ductules with the lateral canals, on account of the large number of those floating corpuscles within the body cavity which greatly obscure the nephridial organs. *F. ambigua* (fig. 21) differs from the preceding species in having six flame cells and ductules on each side of the body, *i.e.* an additional one near the anterior end of the longitudinal duct. *Ambigua* also differs from the other forms in having the membranous tube which encloses the posterior unpaired canal much longer than in the other species; but I did not have sufficient material to determine its exact length. Only in *coronetta* (fig. 23) is there an anterior commissure joining branches of the anterior ductules of the two sides of

the body. In *Floscularia* the flame cells are readily found, but it is very difficult to find all the connections of the ductules and tubules.

Cilia are found only within the flame cells, as a long intracellular tuft or flame, and these terminal cells appear entirely closed off from the body cavity; they have also no connection whatsoever with the lateral antennæ (as one observer had supposed).

Organs of problematical significance.—In *conklini* there is found a large transparent structure (*Gl.*, fig. 25) immediately below the hypodermis (and peripheral to the other internal organs), at the junction of the corona and trunk. It is lobed and forms here a ring just beneath the hypodermis, and attached to it. It appears to be gelatinous. Probably this is a glandular structure, and the dorsal gland of *Stephanoceros* may be homologous.

In *coronetta* a vesicular dorsal, hypodermal structure (*D.Gl.*, fig. 23). probably a gland, is found just below the dorsal sense-organ.

Nervous system, sense-organs.—In all the species the cerebral ganglion (*Cer.*, figs. 20, 22, 23, 25, 28) lies deep below the hypodermis, on the dorsal surface of the vestibulum; it is elongate from side to side and composed of numerous small nerve cells. The nerves arising from it were studied most thoroughly in *campanulata*. In this species (figs. 28, 32) the ganglion seen from the side shows quite clearly a distinction between a dorsal and a ventral portion. From the dorsal side two nerves pass anteriorly to the dorsal sense-organ (*D.Sens.O.*), and a single nerve in the median line posteriorly to end on the hypodermis. From the anterior edge of the ventral portion of the ganglion a large nerve fiber passes antero-laterally to each lateral sense-organ (*L.Sens. O.*); two smaller nerve pairs pass posteriorly from its posterior margin; and from its lateral margin a pair of large nerves on each side downward and backward along the surface of the proventriculus. These nerve fibers could be seen more clearly in life than upon stained preparations; methylene blue staining gave no positive results.

In *coronetta* there is found on the sides of the corona a single pair of small red eyes (*E.*, figs. 22, 23). In some adult individuals of *ambigua* (fig. 20), but not in all, were found a number of eyes, up to five in all, on the dorso-posterior part of the corona; these have an irregular arrangement, and each consists of a few large red pigment granules. *Campanulata* and *conklini* have no eyes in the adult stage. All the species possess an unpaired dorsal (*D.Sens.O.*, figs. 20, 22, 25, 28), and a pair of lateral sense-organs (*L.Sens.O.*, figs. 20, 23, 27, 28) (antennæ) upon the corona, each bearing a tuft of long sense hairs. In *campanulata* the dorsal organ (*D.Sens.O.*, fig. 32) was found to consist of from

four to six hypodermal cells, the sense hairs of which project outward through an aperture in the cuticula.

Female genital organs.—In *campanulata* (*Ov.*, figs. 27, 28), *coronetta* (*Ov.*, figs. 22, 23) and *conklini* (fig. 25) there is a more or less rounded germarium upon the ventral surface of the trunk; its cellular lining is continued caudad as the oviduct (which serves also as an uterus), and the latter opens as an unpaired tube into the cloaca between the openings of the rectum and the nephridia (figs. 29, 30). The germarium consists for the greater part of its bulk of a syncytium of yolk cells with large nuclei (*Yk.N.*) and huge nucleoli; there are some fifteen or more of these cells. At one end of the germarium is a cap of cells with much smaller nuclei, which are ovogonia (*Ovg.*). As the latter increase in size they are pushed in succession into the oviduct, where the cleavage commences. In *conklini* and *campanulata* two or three large ova are found in the oviduct (uterus) at once, in *campanulata* never more than a single one. In *ambigua* the germarium has an entirely different form (*Ov.*, figs. 19, 20); it begins proximally upon the dorsal left-hand side of the trunk, extends down that side, then across the ventral region to the right hand of the trunk, and at the latter point the mature ova are found in the oviduct. I could not determine, owing to lack of material, where the ovogonia are placed within this remarkable germarium.

Body cavity.—This lies beneath the hypodermis, is continued in the coronal lobes, and in the foot as far posterior as the peduncle. In it float masses of minute, brownish, non-cellular corpuscles, which vary in number in different individuals of the same species, and in *conklini* are always exceedingly numerous and very minute. They are dissolved by alcohol, and the larger of them often appear doubly refractive. They must be metabolic products, probably waste products, but I have never found them within the nephridial lumina. In *ambigua* when the animal is fully extended and somewhat compressed in life beneath the cover-glass, it appears as if these corpuscles flowed within special channels between the hypodermis and the infundibulum, and like Gosse (1862) I was at first inclined to believe that there existed here a subhypodermal vascular system. But further study showed that the apparent canals are not fixed structures but simply portions of the general body cavity.

The immature female.—This stage was studied particularly in *ambigua*, but the general characteristics are the same in all the species. This free-swimming stage (Pl. XIX, fig. 21), just hatched from the egg, has only an incipient corona and foot. The other differences from the

adult are mainly the following: Two red eyes (*E.*) are present in all the species except in *conklini*. No coronal lobes are yet developed, but at the anterior end of the trunk is a thickened hypodermal ring bearing a row of vibratile cilia. On the ventral side of and just behind this ring is the mouth opening (*M.*), leading into a capacious infundibulum (from which a vestibulum has not yet become demarcated), the inner lining of which bears long cilia. It is important to note that these cilia lie within the alimentary tract, *i.e.*, belong to its inner lining and thus cannot represent a cingulum. The thickened hypodermal ring becomes subsequently prolonged to form the coronal lobes, and the cilia of the infundibulum are at no time a portion of the corona. Above this portion of the alimentary tract lies a large dense mass, part of which may represent the cerebral ganglion (*Cer.*). The hypodermis of the foot consists of a few enormous cells. A tuft of cilia projects posteriorly from the posterior end of this incipient foot; and in its axis lies a hollow cylinder of cells enclosing a granular, elongate body, which may represent the gland (*F.Gl.*) which forms the peduncle. The tuft of cilia at the posterior end of this embryonic foot was found, in a somewhat older stage of *campanulata* which had attached itself and developed a peduncle, to be still present and placed at the junction of the foot and peduncle; in the figure (Pl. XXI, 38) the cylindrical cellular mass within the foot probably represents embryonic muscle cells of the foot. The remaining organs are essentially as in the adult.

The mature male of F. campanulata.—The males of this species were found in November and the first half of December; the male eggs, as in other *Rotatoria*, are more numerous and smaller than the eggs which give rise to females. The mature male (Pl. XXI, fig. 36) in size and general structure, disregarding the sexual organs and the alimentary tract, shows a great similarity to the immature female. It lacks an alimentary tract entirely, and I was unable to find a nephridial system, though undoubtedly the latter must be present. The thickened hypodermal ring at the anterior end of the body bears a single ring of long, vibratile cilia, and in the projection of the trunk anterior to this ring lie two semicircular, dorsal, red eyes (*E.*). The foot (*F.*) is very short, without peduncle. The hypodermis (*Hyp.*) is thickened and with an irregurlaly scalloped inner contour. A dorsal sense-organ (*D.Sens.O.*) is well developed. In the anterior region of the trunk lies a large mass which may in part represent a cerebral ganglion (*Cer.*). The genital organs consist of a huge sperm sac (*Sp.S.*) connected with a cirrhus (*Cir.*). This sperm sac is filled with spermatozoa, and its walls thin except at one point on its dorsal surface which is thickened;

probably this thickening represents the germinal epithelium and therefore the testis (*Test.*) proper. A curled thick-walled tube, the cirrhus, follows the sperm sac; its lumen, the vas deferens (*V.D.*), is very narrow. A thin-walled short tube connects the posterior end of this cirrhus with the dorsal genital aperture; and within this tube beat long cilia which are attached to the posterior end of the cirrhus. The cirrhus may be protruded some distance out of the genital aperture, and probably serves as an intromittent copulatory organ. On the ventral side of the cirrhus, in close attachment to its wall, is a large dense body (*Gl.*) with an axial pyriform clear space; I interpret this to be a gland, and the clear space to be its duct. Just posterior to this gland is a lobed body projecting into the body cavity, bearing on one of its surfaces long cilia which beat in the body cavity. No further structures were observed in the living animal.

The copulation was not observed. In a number of the females studied at the time the males occurred were found spermatozoa, from one to about a dozen in each female. All seen were within the body cavity of the female and none in any portion of her genital tract. The spermatozoa (Pl. XX, fig. 33) are relatively huge lumbricoid cells, very elongate, the more vibratile end of which appears to correspond to a thick flagellum; they are exceedingly active and twist about within the female, and within the sperm sac of the male, like animated corkscrews.

Concluding Remarks.

The family of the *Flosculariidæ* includes the three genera *Floscularia*, *Stephanoceros* and *Apsilus*. Leidy's description of *Acyclus* is too incomplete to allow us to determine whether this form should be included in the group also. *Apsilus* differs quite markedly from both *Floscularia* and *Stephanoceros* (these two are very similar), but agrees with them in possessing an œsphageal tube, in the similar relations of the nephridial and nervous systems, and in the great similarity of the young. The immature females just hatched from the egg have the foot bearing a tuft of cilia at its distal end.

The general characteristics of the family are as follows, based upon the few species already known anatomically: The anterior portion of the trunk is expanded to form a capacious coronal cup, the free margin of which is prolonged into lobes (*Stephanoceros* and most species of *Floscularia*), or is without lobes (*Apsilus*, *Floscularia edentata* Collins and *pelagica* Rousselet). The whole free margin of the corona constitutes the boundary of a large mouth aperture. Cilia are absent upon the corona in *Apsilus*. In *Stephanoceros* they are arranged

in numerous oblique rows upon the surfaces of the coronal lobes. In *Floscularia* there is in most species a single row of cilia upon the lobes or on both the lobes and the interlobular coronal margin; in a few there are two rows upon the coronal margin (*pelagica* Rousselet, *hoodii* Hudson, *cucullata* Hood, *trilobata* Collins). All these cilia are preoral; they constitute, therefore, a trochus, and there is no postoral row (cingulum) on the external surface of the body behind the mouth. In fact, no postoral ciliary ring occurs, for the diaphragm of *Stephanoceros* and *Floscularia*, which bears a row of cilia, and on that account was homologized by Hudson and Gosse with the cingulum of other *Rotatoria*, belongs to the intestinal tract and not to the coronal margin at all. In the young of *Apsilus* and *Floscularia* the mouth is ventral instead of terminal, as in the adult, and the anterior region of the alimentary tract is ciliated, these cilia not persisting to the adult stage. The diaphragm separates in *Stephanoceros* and *Floscularia* an anterior infundibulum from a posterior vestibulum, both without cilia; in *Apsilus* there is no diaphragm and no distinction of two chambers, and also no ciliation. In two species of *Apsilus*, in *Floscularia* and *Stephanoceros* an œsophageal tube is present. On the vestibulum follows a non-ciliated proventriculus, the posterior end of which is specialized as the mastax; next, a ciliated stomach; then a non-ciliated posterior intestine, then the short rectum opening into the cloaca. The intestinal ciliation is thus limited to the diaphragm, the stomach and (in some species of *Floscularia*) to the rectum.

The foot is well developed in all but *Apsilus;* in this genus it is larger in the young than in the adult, so has probably degenerated. Only in *F. chimæra* Hudson does the foot terminate in two toes (it is doubtful whether this form belongs in the family). In all other forms it terminates in a single peduncle (except in *Floscularia atrochoides* Wierzejski). The foot is strongly contractile, but not retractile into the trunk. The nephridial system is essentially alike in all three genera, likewise the nervous system; no ring nerves have been found in the coronal margin, and there is no subœsophageal ganglion. A dorsal and a pair of lateral coronal sense-organs are always present, and an additional pair of lateral ones in *Apsilus*. The germarium and oviduct are unpaired; the germarium is small and rounded in most species, but much elongated in *Apsilus bucinedax* (Forbes) and *Floscularia ambigua* Hudson. Distinct foot glands are absent in the adult; the only glands connected with the alimentary tract are one pair of stomach glands. A gland around the dorsal sense-organ is found in some forms.

Con.V., contractile vacuole.
C.T., compressor trunci.
Cut., cuticula.
D.A., dorsal coronal arm or lobe.
d.c., deflexor coronæ.
D.Gl., dorsal gland.
Dia., diaphragm.
D.M., dorsal longitudinal visceral muscle.
D.Sens.O., dorsal sense organ.
d.tr. I–IV, depressor trunci primus–quartus.
E., eye.
F., foot.
F.Gl., foot gland.
Fl.C., nephridial flame cell.
Ful., fulcrum inci.
Hyp., hypodermis.
Inf., infundibulum (coronal cup).
L.A., lateral coronal arm or lobe.
l.c., levator coronæ.
L.-C.M., longitudino-circular muscle.
L.M., lateral visceral longitudinal muscle.
L.Sens.O., lateral sense organ.
M., mouth aperture.
Man., manubrium mallei.
Mast., mastax.
Musc., muscles.
Musc.C., muscle cell body.
N., nucleus.
N.c., nerve cell.
N.com., nerve fiber commissure.
Neph., nephridial canal.
Neph.C., nephridial cell.
Neph.com., nephridial commissure.
N.f., nerve fiber.
O., Ovum.
Oes., œsophagus
Oes.T., œsophageal tube.
Ov., germarium.
Ovd., oviduct.
Ovg., ovogonium.
Ped., peduncle of foot.
P.Int., posterior intestine.
Prov., proventriculus.
R.c. I–VI, retractor coronæ primus–sextus.
Ram., ramus inci.
Rec., rectum.
R.M., retractor mastacis.
Sph.An., sphincter ani.
Sph.C. I–VIII, sphincter coronæ primus–octavus.
Sph.tr. I–VI, sphincter trunci primus–sextus.
Sp.S., sperm sac.
Stom., stomach.
Stom.Gl., stomach gland.
Test., testis.
Tub., gelatinous tube.
Un., uncus mallei.
V.A., ventral coronal arm or lobe.
Vac., vacuole.
V.D., vas deferens.
Vest., vestibulum.
V.M., ventral visceral longitudinal muscle.
x., cuticular ridge.
Yk.N., necleus of yolk cell.

PLATE XVIII.—All the figures refer to *Apsilus vorax*.

Fig. 1.—Dorsal view; this and figs. 2–4 represent fully expanded individuals.
Figs. 2, 3.—Lateral (from the right side) and ventral views respectively, the details of the alimentary tract not shown.
Fig. 4.—Newly hatched immature individual, about one-third the size of the adult, the musculature and cuticula not shown.
Fig. 5.—Left half of the mastax viewed from above.
Fig. 6.—Cerebral ganglion and its nerves, sense-organs, anterior portion of the nephridia, and contiguous muscles.
Figs. 7, 8.—Two consecutive transverse sections of a cerebral ganglion, camera drawing.

PLATE XIX, Figs. 9–18.—*Stephanoceros fimbriatus*.

Fig. 9.—Trunk seen from the left side, only the proximal portions of the coronal arms and the foot shown, details of the mastax not drawn. In this as in figs. 10 and 11 only the larger muscles are delineated, and those only in part.
Fig. 10.—Dorsal view of trunk.
Fig. 11.—Oblique ventral view of anterior trunk region with a portion of the coronal lobes.
Figs. 12, 13.—The distal ends of two coronal arms, the first on dorsal and the second on lateral view.
Fig. 14.—Distal end of foot with its peduncle.
Fig. 15.—A nephridial flame cell.

Fig. 16.—An entire individual enclosed within its gelatinous tube, ventral view, the larger longitudinal muscles shown.
Fig. 17.—Germarium, from a stained preparation.
Fig. 18.—Mastax, postero-dorsal view.

igs. 19–21, *Floscularia ambigua.*

Fig. 19.—Germarium seen from left side of the body.
Fig. 20.—Dorsal view of anterior body region, musculature and corona cilia not shown.
Fig. 21.—Immature individual pressed from the egg, seen from the right side; the musculature and mastax not drawn.

LATE XX, Figs. 22–24.—*Floscularia coronetta.*

Figs. 22, 23.—Lateral (from the left side) and dorsal views of anterior portion of the body; the cilia of the coronal lobes not drawn, and only a portion of the musculature.
Fig. 24.—Posterior end of foot with its peduncle.

gs. 25, 26.—*Floscularia conklini.*

Fig. 25.—Anterior portion of body seen from the left side, mastax not drawn, and only a portion of the musculature.
Fig. 26.—The entire animal with its gelatinous tube, from the right side.

gs. 27–35, *Floscularia campanulata.*

Fig. 27.—Oblique ventral view of anterior trunk region, the nephridia not shown.
Fig. 28.—View from the left side; in this figure as in the preceding the coronal cilia are not shown.
Fig. 29.—Germarium from a stained preparation, camera drawing.
Fig. 30.—Germarium, oviduct and posterior portions of alimentary tract and nephridia of an immature individual.
Fig. 31.—Antero-ventral view of the corona.
Fig. 32.—Somewhat oblique lateral view of the cerebral ganglion and its nerves.
Fig. 33.—A spermatozoon from body cavity of a female.
Figs. 34, 35.—Œsophageal tube in two positions of movement.

ATE XXI.—All the figures refer to *Floscularia campanulata.*

Fig. 36.—A male from a tube of a female which contained 8 ova. This mature male measured not more than the length of the dorsal coronal lobe of the female. Viewed from the right side, the musculature and cuticula not drawn, from life.
Fig. 37.—An entire individual within its gelatinous tube.
Fig. 38.—Foot of an immature female, only about one-quarter the adult size, but attached.
Fig. 39.—Mastax, dorsal view, muscles not drawn.
Fig. 40.—Posterior end of foot and its peduncle of an adult individual.
Fig. 41.—Nephridium of the right side of the body.

HISTORY OF THE CARIBBEAN ISLANDS FROM A PETROGRAPHIC POINT OF VIEW (Abstract).

BY PERSIFOR FRAZER, D.ès-SC.

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Our knowledge of the geological history of the Antilles is still very imperfect. Among the titles constituting the bibliography of this subject are:

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(This last work is a compendium of information on the subject and contains an extensive bibliography of the less scientific and more descriptive treatises on the West Indies.)

At the Bath meeting of the British Association for the Advancement of Science in 1888 I presented numerous rock specimens and thin sections cut from them, illustrating a region of about forty miles around Santiago de Cuba. The rocks were partly eruptives and partly classic, but almost all exhibited profound alteration. The thin sections from these eruptives were examined with me by Dr. Hensoldt, Mr. Kunz and Mr. La Croix in this country, and later by Mr. Teall, Mr. Rudler, the Abbé Renard, Prof. Judd and the lamented Prof. George H. Williams in London; all of whom were practically agreed as to the main constituents.

The specimens were divided into:

A. Those from the hills containing the West mine of the Jurugua

[1] A more detailed statement of the observations, in the field and with the microscope, on which these conclusions are based will be published later.—P. F.

Iron Co., near Firmeza. (1) Diorites, some of which contained much altered hornblende and viridite (chlorite), the thin slides filled with microlites and the rocks traversed by epidote veins. (2) Dolerites, diabase (gabbros), with chloritic ground mass, magnetite, rods of feldspar and some olivine.

B. From the hills southeast of that in which the "East mine" was located and about fifteen miles northeast of Santiago de Cuba. (1) Garnet rocks with iron ore (sp. gravity 3.962). (2) Fibrous actinolite, and brown iron oxides partially altered to an epidotic mass. (3) Iron ores (some showing cross lines like the Widmanstätten figures in meteoric iron).

C. From the Sietes Altarés, about thirty-five miles east of Santiago de Cuba. Orthofelsite porphyry (rhyolites), like those erroneously referred to by the late Prof. H. D. Rogers as "jasper," and later recognized by the late Dr. T. Sterry Hunt as a mixture to which he gave the general name "orthophyre"; also like the Arvonian tuffs of Hicks, near St. David's Head, Pembrokeshire, Wales.

D. The specimens from the region of the La Plata mines were quartzites containing hornblende, iron ores and, among the incidental minerals, a claret-red garnet.

In the area described were found upon or associated with the eruptives sandstones, conglomerates and crystalline limestones, laminated iron ores with masses of pyrites not yet converted into the latter. The alteration of the areas of contact in these rocks by the more recent diorite dykes which cut them was evident.

From the character and relations of these rocks I deduced a physical continuity between the Archean of the mainland of the North American continent and the skeleton of the Cuban orographic system.

From the zoölogical and geological researches of Alexander Agassiz in Caribbean and Mexican waters, and the careful studies by Gabb, Crosby, Spencer and Hill, the probability of very great changes of level in the Antilles since the close of the Cretacic period was established, and this probability is fortified by several different lines of proof, *i.e.*, the ledges and shelves of the island borders, the wide distribution of the white radiolarian limestones, etc., and finally petrographic examinations of material from the several islands.

Prof. Crosby pointed out orographic reasons for assuming a former "bridge" (*i.e.*, causeway) between the Greater and Lesser Antilles. As he says, the mountains of "the northern arm of the island of San Domingo point toward Cape Maysi on Cuba," and the northern range in Cuba "regains the western trend and points directly toward Yucatan."

He also alludes in his paper of December 13, 1882, to the "axis of old eruptive rocks" of which, so far as he has been able to learn, "each member of the group consists." He does not give his authority for this statement nor say to what age he ascribes these eruptives; but if he contemplated the possibility of its being pre-Cambrian he anticipated by six years two of the strongest grounds for my belief in the physical continuity of the Great and Little Antilles, and the present exposure of parts of the nucleus which are of great age and possibly have never been covered by sedimentary rocks.

His observation that this nucleus is flanked on either side by schists and slates has been fully confirmed, and I have been tempted to class these with the mica schists of the Appalachians, and the feldspar porphyry (rhyolites) with the Arvonian tuffs of south Wales.

Dr. W. Bergt strongly supports the Archean age of the nucleal axis of San Domingo if not of all the Caribbean Islands in the following words:[2]

"Das archäische Alter welches P. Frazer für die Centralketten des südöstlichen Cuba feststellen konnte, und das er für ganz Jamaika, für San Domingo, Puerto Rico, und die Windwardinseln vermuthete, kann nunmehr bestimmter für San Domingo angenommen werden."

It may be, as Mr. Hill suggests, that no "Paleozoic nucleal rocks" have been established with certainty in "Cuba and Santo Domingo" or any other of the border lands of the "American Mediterranean,"[3] although de Castro imagined he had discovered such near Cienfuegos, yet this fact would not preclude the possibility that part of these nucleal rocks are pre-Cambrian.

To summarize the observations:

(1) There is a complex of diorite, felsite and rhyolite forming the axes of the mountain ranges of eastern Cuba.

(2) With these are associated schists which in places assume a gneissoid character.

(3) The diorite and the clastic rocks resting on it are traversed by numerous veins of later eruptives, on the contact planes of which latter many phenomena of alteration may be observed.

(4) No such indications of alteration are apparent at the contacts with the older diorite mass, but, on the contrary, the sedimentary rocks seem to have been deposited upon it without disturbance.

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[2] "Zur Geologie von San Domingo." *Abh. der naturw. Gesel. "Isis" in Dresden*, 1897, Heft II, p. 64.

[3] *Cuba and Porto Rico*, p. 384.

(5) All the rocks earlier than the intrusive veins, and even parts of these latter, show extensive alteration and probable transformation.

One purpose of this abstract is to recall the fact that we have proofs of physical connection with the Western Continent of these outlying islands, not only from the physiographic features; drowned valleys; submerged plateaus; trend of conformation through the major axes of the present detached islands; palæontological analogy with South American forms of life; etc., but, in addition to all these, the close petrographical relationship of the crystallized and crystalline rocks and their congeners with those of the mainland.

Note.

A paper has just been received from Dr. Callaway (December 27, 1902) on the Plutonic complex of Central Anglesey,[4] in which some very curious resemblances appear between the central complexes of Anglesey and Cuba, dissimilar as are the more recent mantles with which in the two cases these nuclei are clothed.

In 1880 Dr. Callaway, in entire accord with Dr. Hicks and many of the non-official geologists of Great Britain as well as of our compatriot, Dr. T. Sterry Hunt, had established the pre-Cambrian age of these Anglesey rocks. In 1888 the Rev. J. F. Blake had confirmed a note previously made by Dr. Callaway of the production of schistosity in diorite by pressure. In the eastern district of Anglesey Dr. Callaway considers felsite and diorite the materials out of which the gneiss was made: "but with them is associated the well-known binary granite (haplite) originally called Dimetian by the late Dr. Hicks. A fourth variety . . . . is the quartz-felsite claimed by that geologist as Arvonian. It forms a part of the same magma as the granite, and must be carefully distinguished from quartzless felsite, into which it is sometimes intruded in dykes and veins."

After dividing the diorite and its modifications into hornblende-gneiss, decomposed diorite and chlorite-gneiss, micaceo-chloritic gneiss, and kersantite and biotite-gneiss, he says of the felsite that he "has never succeeded in obtaining a specimen in its original state," and in analysis it is almost indistinguishable from Vom Rath's rhyolite of the Euganean Hills, and from a rhyolitic obsidian from Medicine Lake. With the above are associated crystalline limestones, of which the origin, according to Dr. Callaway, is chemical segregation and not sedimentation.

[4] *Quart. Journ. Geol. Soc.*, Vol. lviii, 1902.

The granite (haplite) and quartz-felsite, according to him, are intruded into the diorite and felsite after the production of schistosity.

Seams of quartz and feldspar (haplite) alternate with seams of biotite and feldspar (modified diorite) when the veins lie in the planes of shearing of the diorite, and the result is a banded gneiss.

The quartz-felsite forms part of the same magma as the granite. Of two thin slides of the gneiss formed by schistose felsite intersected by numerous granite veins, Prof. Bonney "thinks much of the mica secondary."

The paper concludes thus: "The following would seem to have been the sequence of events in the central complex. Diorite was first consolidated. It was then penetrated by masses and veins of felsite, and blocks of it were isolated from the main mass (or masses) and floated off into the felsite. The consolidation of the felsite was the next stage. Earth-pressures then affected both diorite and felsite, producing schistosity. A granite magma, usually haplite, sometimes quartz-felsite, then invaded the area, penetrating the diorite and the felsite in large masses, and sending into them countless veins, which commonly found their way along planes of schistosity, giving rise to banded gneisses."

Summary of Results.

"(1) The central complex of Anglesey was originally composed of diorite, felsite and granite.

(2) The diorite has been modified into an elliptical dome of dark gneiss, namely, into simple gneisses by pressure, and into complex gneisses by pressure *plus* granitic intrusion.

(3) The intrusion of the granite into the diorite has often produced fusion at the contact, sometimes with the generation of biotite in the diorite.

(4) The diorite and dark gneiss form an insular mass surrounded by granite.

(5) The felsite has been modified into quartzose and micaceous schists and gneisses by pressure, and into banded gneisses by the addition of granitic intrusions.

(6) The quartz-felsites of the area are a part of the granitic magma.

(7) Both diorite and felsite were modified into gneisses and schists prior to the intrusion of the granite and quartz-felsite, which are not foliated."

POLYCHÆTA FROM THE COASTAL SLOPE OF JAPAN AND FROM KAMCHATKA AND BERING SEA.

BY J. PERCY MOORE.

Hitherto our knowledge of Japanese Polychæta has been limited to collections made in the littoral zone at several points along the southeastern coast between Yokohama and Nagasaki and ably described in three papers by v. Marenzeller, a few species from the Japan Sea described by Grube and McIntosh, and to the results of about half a dozen dredge and trawl hauls made by the "Challenger" at points off Japan, which have been recorded by McIntosh.

At the close of an extended cruise in the South Pacific Ocean, the United States Fish Commission steamer "Albatross" spent the month of May and part of June, 1900, in dredging and trawling along the continental slope of Japan. During this cruise the vessel was in command of Captain J. F. Moser, U. S. N., with Dr. H. F. Moore as naturalist, to whom, and to Dr. H. M. Smith, of the Fish Commission, I owe the pleasure of studying the rich and interesting collection of Polychæta taken.[1]

During May a line of about seventy dredging stations was run along the coast of Nippon or Hanshu from Yokohama westward about 200 miles, through Sagami and Suruga Bays and the Totomi Sea. These stations were mostly along the steep slope on the inner border of the Black Current, and about or within the 100-fathom line, though the trawl was sometimes sent down to much greater depths. In early June, ten additional stations were established along the coast of northern Nippon, beginning at the lower end of Sendai Bay and extending for about 120 miles northward, entirely within the 100-fathom line. Later in June several dredgings were made in the shallow waters and muddy bottoms off Kamchatka, and others north of the Aleutian Islands in the southern portion of Bering Sea. The details of location, depth, character of bottom, etc., will be found in a list of dredging records of the "Albatross" compiled by Mr. C. H. Townsend, and published in the *Report of the U. S. Fish Commission* for 1900. In this paper it has been thought necessary to give only the depth and

[1] Acknowledgment is due to Hon. George M. Bowers, Commissioner of Fisheries, for permission to publish the results in this form.

general locality, together with a list of the station numbers at which each species was taken.

All of the species contained in the collection have been determined and, with the exception of the families *Sabellidæ* and *Serpulidæ* and several species of other families which have been reserved for further study and comparison with material not now available, are recorded in the following list. A large number of species, either new or hitherto unreported from that region, are added to the Japanese fauna. One of the surprises of this study has been the very small number of Marenzeller's species which were taken by the "Albatross." Of the species previously known most of them belong to the circumboreal fauna. several were dredged by the "Challenger" at points off Japan, and the others have been recorded from various more or less distant parts of the world. As Marenzeller has in preparation an account of the geographical relations of the Japanese Polychæta, nothing more need be said on this subject. The general results remind one of those attained by Verrill along the Gulf Stream slope of North America.

POLYNOIDÆ.

Harmothoë imbricata (Linn.) Mgrn.

The setæ of the two small specimens taken are colorless and the neuropodials slender.

Totomi Sea, 3,715, 65 fms.; Totomi Sea, 3,725, 12–13 fms.

Lænilla subfumida (Grube).

This is one of the very few Philippine species which have been found on the coast of Japan, from which it has not been hitherto recorded.

Sagami Bay, 3,702, 31–41 fms.

Polynoa semierma sp. nov. (Pl. XXIII, figs. 2, 3.)

Form long and slender, composed of 64 somites and measuring 42 mm. in length and 3 mm. in breadth, exclusive of parapodia.

Unfortunately the prostomium is in a very bad state of preservation and much altered, with all of the appendages, excepting one palpus, lost and only their position indicated by scars. The general shape of the prostomium is much as in *Harmothoë*, the anterior peaks being well-marked, pointed and widely separated. The left palpus has a length of four times the width of the prostomium and is slender and regularly tapering. Two pairs of black, very small, circular eyes can be distinguished, one lateral, about the middle, the other dorsal, near the posterior margin of the head. The protruded proboscis bears the usual jaws, but the papillæ have been destroyed. It has a length of 3.5 mm.

The parapodia are long and slender and especially so toward the caudal extremity. Neuropodium conical, divided terminally into pre- and post-setal lobes, both prolonged dorsally, and the former the larger; ventral surface studded with large spherical papillæ on short stalks. Notopodium a small, slender, freely projecting process supported by a distinct aciculum. Dorsal cirri with small ceratophores, and long, slender, regularly tapered styles which reach considerably beyond the setæ tips anteriorly, but posteriorly, owing to shortening of the cirri and lengthening of the feet, fall short of the setæ tips. Ventral cirri short, less than ⅓ dorsal, thick basally and slender terminally; posteriorly they undergo the same relative change of position as the dorsal, and for the same reason.

Only about ¼ of the total number of elytra are *in situ* and are very easily detached, but the elytrophores indicate 25 pairs placed on the following somites: II, IV, V, then on alternate somites to XXIII, then on XXVI, XXIX, XXXII and XXXIV, and after that on every third somite to LXI. They are small, leaving a large portion of the back exposed, delicate and usually much distorted, nearly circular, with central attachment and quite without papillæ or hairs of any kind; the medial half is reddish-brown, the lateral unpigmented.

Notopodial setæ are totally wanting, but there is a relatively stout tapering aciculum. The neuropodial setæ are disposed in about 9 close rows; all are nearly colorless and rather slender. Those of the dorsalmost row or two form a distinct group which project beyond the others, and probably serve somewhat the purpose of the notopodial setæ of other species; their shafts are scarcely more than ½ the diameter of the other neuropodials and the ends are much prolonged and provided with close transverse rows of fine hairs quite to the simple tips. The others have the usual form, the more dorsal ones with simple tips and as many as 14 transverse combs, the middle and ventral ones with a more or less prominent accessory tooth at the tip and shorter enlarged ends with as few as 8 combs on the most ventral setæ.

Sagami Bay, 3,698, 153 fms.

Scalesetosus formosus sp. nov. (Pl. XXIII, figs. 4, 5, 6.)

This species is referred to McIntosh's genus on account of the form of the head and neuropodial setæ, the latter being very characteristic; in many other respects it departs widely from the generic type. The single example on which the description is based is complete, but broken into three pieces, and with the scales detached. At the posterior end is a small regenerating piece, but the form of that region, and especially the structure of the parapodia, indicates that it is of prac-

tically the normal length. The form is slender and tapers very slightly to the caudal end. The total length is 24 mm., the maximum width of the body 2 mm., and between the tips of the parapodia 4.5 mm.

Prostomium about as broad (across the ocular lobes) as long, marked for its entire length by a median dorsal groove which widens anteriorly to a broad and deep cleft separating the rounded frontal lobes or peaks; the narrowest part of the prostomium is at the posterior border, anterior to which the lateral borders diverge, then swell out abruptly at about the middle as prominent rounded lobes which bear the anterior pair of eyes. Ceratophores of tentacles nearly spherical, possibly the result of contraction; the median crowded between the cephalic peaks into the frontal cleft; the lateral partly beneath the median and well below the peaks; style of median antenna lost; the lateral very short and thick, scarcely longer than its ceratophore, and its diameter equal to ½ its length, ovate pyriform and little pointed. Palpi slender, tapered regularly to tip, about 2¾ times length of prostomium. Eyes 2 pairs, both very large, especially the anterior, but lightly pigmented, the anterior pair situated on the ocular lobes, the posterior slightly caudad and mesiad, and nearly or actually in contact with the anterior.

Tentacular cirri, or at least the ventral, which alone remain, about ½ as long as palpi, to which they have a similar form, with the distal half more slender. There are 57 somites in addition to those in regeneration, and all but the peristomium and pygidium are setigerous. Ventral surface smooth, sole-like, with rounded margins separated from the bases of the parapodia by a groove on each side. No visible nephridiopores or papillæ. Elytrophores prominent, nearly cylindrical or slightly tapering; the median space of the back scarcely exceeding in width their diameter.

Parapodia large and prominent, similar throughout the series, except that the dorso-ventral diameter decreases toward the posterior end. Neuropodium much larger than notopodium, broad, flat, leaf-like, its lateral margin broadly rounded, the ventral convex, and dorsal concave, so that as a whole it appears to have a slight curvature dorsad; at the end it is split into two vertical plates, both, especially the posterior one, being very thin and embracing the bases of the setæ between them for a considerable distance. Notopodium a rounded lobe arising from the anterior side of the dorsum of the neuropodium about its middle. Like the elytrophores, the dorsal cirrophores are remarkably large; although arising much nearer the base of the parapodia they reach as far laterad as, and at the same time much dorsad to, the noto-

podia; styles formed like the palpi but more slender, reaching scarcely beyond the tip of the neuropodia. Ventral cirri with short globular cirrophores placed about opposite to the notopodia; styles thickened basally but with filiform distal halves, and their tips just reaching the ventralmost neuropodial setæ. First ventral cirrus closely approaching the tentacular cirri in length.

Elytra 29 pairs, on II, IV, V, then on alternating somites to XXI, then on XXII, XXIV, XXVII, XXX, XXXI and again on alternating somites to LVII; all are in symmetrical pairs, and are easily detached, which is the condition of most of them. The first is nearly circular, the last somewhat triangular, the others broadly ovate with a slight excentric postero-lateral attachment. They are thin, smooth, colorless and translucent; with a very distinct nerve ramifying from the rear of attachment in dendritic fashion throughout the scale; there are no cilia nor papillæ, but numerous pellucid dots are scattered over the surface, in the center of each of which a small sense-organ appears.

Notopodial setæ few and irregularly arranged; they are short, reaching only half-way from their points of origin to the end of the neuropodium, slender, rather strongly curved, pointed and with transverse rows of excessively fine teeth along the convex border and half way or more around the seta. Neuropodial setæ arranged in a single vertical series which spreads in a broad fan-shaped figure, slightly separated into dorsal and ventral halves, slender and very long, probably quite equalling the parapodium when fully protruded, somewhat enlarged and bent below the slender, tapering, very finely serrulate, slightly hooked and undivided end; at the region of the thickening is a half ring of long, fine, comb-like teeth supported on a slight shoulder, which is placed on the ventral side of the setæ in the dorsal half of the bundle and the dorsal side of those in the ventral half. The most ventral setæ have shorter, stouter and more strongly hooked tips. Both notopodial and neuropodial setæ are colorless and beautifully transparent. The setæ of the first setigerous foot differs in no appreciable respect from the others.

Only the type known from Sta. 3,703, Sagami Bay, 31 fms.

Lepidonotus chitoniformis sp. nov. (Pl. XXIII, figs. 10, 11.)

Form short and broad, with a regular elliptical outline, depressed; the greatest width, whether measured between the tips of the setæ or the margins of the body, at the middle. The type measures 37 mm. long, 16 mm. wide, and 6 mm. deep.

Prostomium roughly square, the anterior and lateral margins slightly convex, the posterior concave; a pair of prominent posterior lateral ocular lobes, and the production of the anterior face into the

lateral tentacular ceratophores modify this form. Eyes 2 pairs; the anterior large and partly on the base of the posterior lateral lobes, as a consequence of which they face both forward and outward; the posterior are about ½ the diameter of the anterior and are situated nearly on the dorsal surface close to, but slightly mesiad and caudad of, the ocular lobes.

Ceratophore of median tentacle about ⅔ as long as prostomium, stout and distally swollen; style 4 times length of prostomium, slender, slightly tapering, with an abrupt egg-shaped subterminal enlargement having the large end distad, and followed by a terminal filament of equal or slightly greater length. Lateral tentacles similar in form to the median but only about ⅔ as long, and the ceratophore only ½ as long as that of the former. The colors of the tentacles are well preserved and striking in their contrast with the colorless head; the ceratophores are ringed with yellowish-brown, the basal half of the style strongly tinged with brown, the proximal half of the subterminal enlargement deep brown, and the rest pure white. Palpi about equalling median tentacle, rather stout, but their bases not enlarged nor extending laterally beyond prostomium, gently tapering, abruptly sharp pointed, but without terminal filament, densely ciliated, basal half pale brown.

Peristomial parapodium long, slender, reaching to the level of the tip of the tentacular ceratophore. Tentacular cirri similar in form and color to the tentacles but with somewhat longer terminal filaments, the dorsal equalling the median tentacle, the ventral somewhat shorter.

There are 26 somites, of which 25 bear setæ and 12 elytra. The nephridial tubercles occupy the usual position and point strongly laterad and slightly ventrad and caudad; the last pair, on XXVI, are in contact mesially and all except the first, on VI, are prominent.

Prominent dorsal papillæ occur on all the somites from II to XX inclusive, being median on II and on XV to XX, and in double paramedian series on III to XIV inclusive. The first one is a low, flat, nearly quadrate nuchal tubercle which somewhat overlaps the prostomium from behind; from III to XIV each somite bears a larger anterior and a smaller posterior pair; on III those of each pair are close together and united by slight transverse ridges; the others are well separated, the median interspace increasing in width with the segments; somites XV to XIX have each a single larger anterior and a smaller posterior papilla, and XX the large one alone.

The elytrophores are large and shaped like the body of an oyster or even more like the human external ear viewed from the cephalic side.

On the cirri-bearing somites are smaller, and structurally somewhat simpler, but essentially similar structures, through which transverse muscles pass into the parapodia and dorsal cirri. As will be indicated below, they bear branchial filaments similarly to the elytrophores, with which they are obviously homologous.

Branchial filaments occur on every somite from III to XXIV inclusive, except XXIII, the last somite bearing elytra, and minute rudiments on the anterior side even of XXV and XXVI. They appear to be mere hollow integumental sacs generally of simple finger-like form. On elytra-bearing somites they are disposed as follows: One arises from the antero-external and one from the postero-external margin of the elytrophore. The former is present on every elytrophore except the first and last, is unbranched but bends sharply laterad at a right angle. The latter is longer, and on typical somites divides into a short medial and a long lateral branch diverging at right angles from the short stem; it is altogether absent on the first and the medial branch is wanting on the 11th and a few of the anterior elytrophores. On the parapodium are 2 dorsal, 5 or 6 anterior and 4 or 5 posterior filaments (in addition to 1 or 2 rudimentary ones on the base of the elytrophores), the most ectal one in each case being bifid. Anterior to the 5th and posterior to the 11th elytra-bearing somite this arrangement is simplified by reduction in the number of filaments. Essentially the same arrangement obtains on the cirri-bearing somites, but the filaments are more numerous, larger and sometimes even trifid. The elytrophore filaments are represented anteriorly by 2 simple ones, and posteriorly by 3, of which the middle one is bifid. There are usually 5 dorsal parapodial filaments, of which one at the base of the cirrus, like the most external on the anterior and posterior faces of the parapodia, is usually trifid.

The parapodia are stout, with the neuropodium of a somewhat compressed, obliquely truncated conical form and the notopodium a rather prominent short tubercle on the anterior dorsal face near the base of the parapodium. The ventral surface of the parapodia, and indeed of the entire body, is covered with a close nap of short, fine processes. Ventral cirri with low tubercle-like ceratophores borne on the middle of the ventral neuropodial surface; their styles short, scarcely reaching half-way to the end of the foot, the basal half stout and swollen, the distal tapered to a sharp point, but with no proper filament. The dorsal cirri are quite long, their filamentous tips at least reaching quite beyond the setæ line; they have exactly the shape and color of the tentacular cirri, but on the base of each is a prominent bilobed glandu-

lar swelling; the last pair, instead of being longer, is shorter than the others; otherwise both ventral and dorsal cirri present the usual modifications toward the end of the body.

The very regular outline of the body, when seen from above, is due to the dense tufts of dorsal setæ which project beyond the margins of the scales and conceal all but the tips of the ventral setæ, and from below to the remarkably even arrangement of the neuropodia and the ventral setæ. The dorsal setæ are very numerous and spread chiefly in a horizontal plane, but in such a way as to overlap successively from behind forward. They are very delicate, capillary, tapering from base to tip and furnished with fine but distinct opposite or nearly opposite processes of a length 3 to 4 times the diameter of the stem. The ventral setæ are arranged in very regular horizontal rows, 7 or 8 of which are subacicular and 2 supraacicular; except the dorsalmost and ventralmost rows, which have fewer, each contains 4 setæ. They are of a beautiful pale amber color, and transparent, moderately stout, slightly curved and with the tip smooth and strongly hooked. As in *Euphione* they are densely bearded toward the end, about $\frac{1}{3}$ or $\frac{1}{4}$, according to the position of the seta, of the exposed part being provided with numerous rows of long fine hairs, the terminal ones of which curve backward and envelop the tips. On the first setigerous somite the ventral setæ are slender and tapering, with a close beard of fine hairs.

Twelve pairs of elytra are borne on somites II, IV, V, VII, IX, XI, XIII, XV, XVII, XIX, XXI, and XXIII. They are large, strongly imbricate and decussate, and so close-fitting that their boundaries can scarcely be distinguished except at the margins; the attachment to the elytrophores is unusually firm. The first is irregularly circular with a nearly central scar, the last roughly triangular, and the others more or less bean-shaped, the more anterior ones being deeply emarginated and asymmetrical. The 7th is the largest and the size falls off each way to the 1st and 11th, the 12th again becoming larger. Cilia form a strong marginal fringe around more than $\frac{3}{4}$ of the circumference of the scale, only the covered anterior portion being free; they are longest and coarsest on the lateral half of the anterior border, from which large papillæ are wanting, and where they are about equal to the longest papillæ present on the scale; a small group of rather large ones occurs also on the medial margin. Small cilia are scattered sparingly over the greater part of the exposed surface of the scales and are larger and more numerous on the area external to the scar ridge. The papillæ are remarkable for their size and form, and cover the entire upper surface. The anterior medial region and a narrow area along the ante-

rior lateral border bear only small, low, smooth papillæ; from these areas they gradually differentiate into several distinct forms. Lower flat papillæ with from 4 to 8 peripheral radiating spines occur chiefly on the postero-lateral half; a few especially large examples of this type which lie just behind the scar ridge may bear 1 or 2 apical spines in addition to the peripheral ones. Smooth globular papillæ without spines are occasionally found with the latter. Along the scar ridge are 1 to 3 (of which the mesial one is the largest and most characteristic) very large papillæ having the form of an irregular inverted cone, the enlarged end of which is thickly studded with rough processes. On the entire area between the lateral end of the scar ridge and the postero-lateral margin are numerous large, pale or colorless, erect, clavate papillæ with slender pedicels, and studded with peculiar rough scaly nubs. A single marginal rank of similar but larger, recumbent and usually brown papillæ extends around the entire postero-internal border. The papillæ vary much in color; those on the ridge are generally yellowish-brown, the others varying shades of yellowish-gray, gray with yellow spines, brown or nearly black. The darkest are usually found in a small group just mesiad of the scar ridge. The 1st scale bears a central group of the large rough papillæ and a complete marginal circle of clavate ones, beneath which is a circle of short cilia. The last has club-shaped papillæ on its lateral margin only, and nearly its internal half is free from cilia.

When the scales are in place the entire animal presents a striking superficial resemblance to a *Chiton*. The rough scale ridges converge in each pair to form a series of V's pointing forward.

Type, Sagami Bay, 3,700, 63 fms.; Totomi Sea, 3,733, 49 fms.; also one from an unknown station.

Lepidonotus branchiferus sp. nov. (Pl. XXIII, figs. 7, 8, 9.)

Outline short, broad, elliptical, very regular, somewhat depressed. Length 26.5 mm., width to tips of setæ 14 mm., to margins of scales 11 mm., depth 6 mm.

Prostomium decidedly wider than long, its lateral margins with prominent preocular protuberances, making this the broadest region; eyes two pairs, rounded, black, the anterior much the larger and more prominent, the posterior distant from them less than their own diameter mesiad and caudad. Median tentacle with stout cylindrical basal piece slightly shorter than prostomium; style about 4 times the length of prostomium, tapering to a slender region beyond which is a subterminal ball and a short terminal filament. Lateral tentacles with ceratophores less than ½ that of median tentacle, and continuous with

frontal processes of head, which are slightly dorsad of the level of the median ceratophore; style similar in form to median but with a relatively longer terminal filament which reaches only to the median ball. Palpi with very broad, widely separated bases, fully half of which project beyond the sides of the head; otherwise they are similar in form to the palpi of *L. chitoniformis;* basal $\frac{2}{3}$ brown, the rest white.

Peristomial parapodia not quite reaching to tip of median tentacular ceratophore; the dorsal tentacular cirrus, which alone remains in the only specimen, similar in form to median tentacle, but with a longer filament, and the entire style slightly shorter. The protruded proboscis has a length of 6 mm. and a diameter of 3.7 mm. It bears four light brown fang-like jaws of the usual form, and thirteen papillæ above and thirteen below, all but the small lateral ones, which are simple, being strongly curved, compressed and bilobate. There is also a transversely elongated low subterminal ventral papillæ.

Total number of somites, including peristomium, 26; setigerous somites 25; elytra 12 pairs. Nephridial papillæ may be detected as far forward as IV, but the first 3 are very small, the others exactly as described for *chitoniformis*. Except that the difference in size between the anterior and posterior ones of the dorsal series is less evident, the dorsal tubercles are exactly as in *L. chitoniformis*. No important differences are to be noted in the form and structure of the elytrophores.

The branchiæ have the same arrangement as in *L. chitoniformis* and, although fewer and simpler, are larger and more conspicuous than in that species. All are rather long and slender and entirely unbranched, and are directed more or less laterad and dorsad. None occurs on the dorsum of the parapodium. On the elytra-bearing somites one arises from each the posterior and anterior border of the elytrophore, the former being somewhat the larger and more laterad. On the anterior face of the parapodium is a series of about 3, arranged along a line from the one mentioned above to the base of the ventral cirrus, to which, however, it does not reach; one or two smaller detached processes may lie ventrad of the middle of this series. On the posterior face usually 3 in a group are found below the outer end of the elytrophore, at a lower level than the anterior series. On the cirrhiphorous somites the arrangement differs slightly. A short anterior one arises from the border of the ridge passing to the cirrus; an oblique series of 4 occurs on the anterior face of the parapodium. Posteriorly there are two marginal, a cirral which arises from the base of the cirrus in actual contact with its posterior gland, and 2 or 3 others lower down on the posterior

face of the parapodium. Toward the ends of the body the number of branchial filaments diminishes.

The parapodial dorsal and ventral cirri are much the same as in *L. chitinoformis*, but the dorsal cirrus is somewhat shorter, just barely reaching the ventral setæ tips; its knob is generally more spherical, and its basal glands, while similarly arranged, much longer.

Both dorsal and ventral setæ are similar in their arrangement to those of *L. chitoniformis*. The former are shorter than in that species, leaving the entire bearded portion of the ventral setæ exposed from above, and are more slender, softer and more densely provided with longer lateral processes, which are arranged either in tufts or whorls, the exact arrangement being uncertain owing to the presence of an incrustation of foreign matter. The latter are somewhat stouter, with shaggier beards of fewer rows of hairs; one was found with a terminal sheath still partly in place.

In number, arrangement, form, and even in the character of their papillæ and cilia, the elytra of this species approximate those of *L. chitoniformis*. The chief difference lies in the larger size of the granules and the strong tendency of the papillæ to become spinous. The papillæ immediately surrounding the low scar ridge are of a stellate form with long, sharp-pointed rays bearing one or more conical spinous on the upper side. The largest of this type are posterior to the ridge, where occur also a few nearly globular papillæ bearing a single long conical spine. On the medial side of the scar ridge these papillæ become gradually more irregular and oblique, finally passing into the smaller papillæ whose pointed summits are directed toward the posterior margin of the scales. Toward the covered area of the scale all papillæ become smaller and smoother, and soon low, rounded and colorless. Clavate papillæ occur in the lateral area, and in a postero-lateral marginal row; they are relatively smaller and much more slender than in *L. chitoniformis* and bear numerous prominent conical points instead of rough nubs. The erect ones of the lateral area bear a number of spines, varying with the size of the papilla, along all parts of their sides and summits, whereas the reclining ones of the marginal row have spines on the upper or exposed surface only. Over the region of the scar, in addition to the stellate papillæ, which there attain their maximum size, are from 4 to 6 particularly prominent papillæ crowned with numerous short spines arranged in a tuft. In spite of their roughness all of the papillæ, even the largest, are soft. The covered portions of the scales and the lateral zone are colorless, the middle and posterior parts yellowish-brown, against which the various colored papillæ

stand out clearly. The larger papillæ are chocolate-brown, reddish-brown, yellowish-brown, partly brown and partly yellow, or, in striking contrast, white, and it is very seldom that two adjacent ones are of the same color.

One specimen, type, Sta. 3,702, Sagami Bay, 31–43 fms.

L. branchiferus and *L. chitoniformis* are evidently closely related to *L. giganteus* Kirk from New Zealand which, according to Thomson, possesses essentially similar branchiæ and dorsal tubercles, and exhibits additional features of resemblance in the elytra and setæ. In a number of respects all three depart from the typical species of *Lepidonotus* and might very properly be segregated as a distinct generic group. *Lepidonotus branchiata* (Treadwell) from Porto Rico possesses similar branchiæ, but the setæ and elytra are quite different and no reference is made in the description to dorsal tubercles.

Lepidonotus cælorus sp. nov. (Pl. XXIII, fig. 12.)

The form is, as usual in the genus, short and compact, but much more slender than the 2 species just described; the largest specimen measures 25 mm. long, exclusive of the tentacles and anal cirri, and 8 mm. wide to the tips of the setæ. Number of somites 26, 25 bearing setigerous parapodia, and 12 elytra. Ventral surface smooth, with nephridial papillæ from VIII to XXV inclusive; all but the first are prominent and tubular and project freely caudo-laterad.

Prostomium slightly wider than long, though the continuation of the peaks into the bases of the lateral tentacles gives it a somewhat elongated aspect. Eyes normally 2 pairs, which have coalesced in the type; the posterior near the caudal end of the lateral surface, but not concealed by the nuchal fold, looking latero-dorso-caudad, heavy black, circular; the anterior lateral, at the point of greatest width, looking latero-dorsad, larger than the posterior and elliptical or crescentric, black.

Except the palpi the cephalic appendages are very easily displaced, and the median tentacle is present in the type alone. Its total length is about 5 times the head, of which $\frac{1}{6}$ is made up of the basal piece and $\frac{5}{12}$ of the filamentous tip; basal piece constricted at the middle, the proximal portion more opaque and smoother; style slender throughout and tapering to a slightly subterminal enlargement, beyond which it diminishes suddenly to the filiform tip. The lateral tentacles are more often preserved and vary considerably in length. They have the same general form as the median tentacle, but are longer and decidedly more slender, with the subterminal enlargement scarcely evident, and the filiform tip longer (up to $\frac{1}{2}$ of the entire length); the basal

piece, which is continuous with the prostomial lobes, is slightly shorter, and arises at a slightly more ventral level. Palpi about 3 times length of prostomium, thickened basally, tapered to end, which bears a very short terminal filament.

The peristomium presents no noteworthy features. Tentacular cirri similar to lateral tentacles, the dorsal somewwhat exceeding median tentacle, the ventral slightly shorter; the slender parapodium, which supports them, reaching beyond the tentacular basal pieces.

The typical parapodium (X) presents the following features: neuropodium large, nearly truncate or slightly angulated at the point from which the deep brown aciculum protrudes, ventral margin horizontal, dorsal sloping with a slight curve to the elytrophore; notopodium a mere lobe on antero-dorsal face of neuropodium, supported by a slender aciculum. Ventral cirri with a short filiform appendage, the tip of which falls short of the bases of the neuropodial setæ; dorsal cirri borne on prominent ceratophores which have a dorso-caudad position with relation to the foot, similar in form to the tentacular cirri, about 2½ times as long as the ventral cirri, of which length the ceratophore constitutes ⅓.

The ventral cirrus of the 1st foot is, as usual, longer; on the last two the dorsal ceratophores become posterior; the last foot lacks the notopodium, or at least the notopodial setæ. The anal cirri are the longest appendages of the body, fully twice the dorsal cirri, and bear very long filiform tips.

Twelve pairs of elytra are borne on somites II, III, IV, VI, VIII, X, XII, XIV, XVI, XVIII, XXI and XXIV. They are strongly imbricated and tough, membranous and firmly attached. With the exception of the first and last they are elongate-pyriform, or more ovate posteriorly, attached posterior to the middle, and with the slender pre-peduncular portion covered by the preceding scale; the first is broadly ellipsoidal, the last roughly triangular with the longest side mediad and the angles rounded. With the exception of a narrow smooth area at the anterior end, the entire dorsal surface of the scale is thickly clothed with papillæ of various kinds. Anteriorly are a few small conical spines with apices directed obliquely toward the posterior margin of the scale. Farther back they become larger and more numerous and distinctly differentiated into two forms distributed to the internal and external halves of the scale. On the external area they remain smaller and depart less from the simple conical form, but most of them develop a few jagged points at the apex and become more elevated, especially those of a marginal series, which are larger and somewhat club-shaped. On

the internal area a gradual transition into larger, rounded, rough papillæ takes place, especially over the area of attachment where this kind occurs nearly exclusively; but elsewhere they are interspersed with papillæ of the same type as, but larger than, those of the external area. The large papillæ are of a globular or haycock form and reach a diameter of 10 or even 20 times that of the spines. Their surface markings are very peculiar and characteristic, somewhat resembling the chasing of a cane or umbrella head, but rougher than such work is customarily. Sometimes the markings are very regularly arranged in rows converging to the apex, and may then be simply roughened ridges and grooves, or rows of overlapping scales or even spines. The first and last elytra are the roughest of all and have the largest papillæ. A strong fringe of long cilia marks the posterior external margin of typical scales and nearly encircles (except for a small part of the internal margin) the first. The longest have a length of about $\frac{1}{8}$ or $\frac{1}{7}$ of the greatest transverse diameter of the scales, but become much shorter on approaching the mesial side, along the whole exposed portion of which they are continued as integumental sense-organs of gradually diminishing length.

The notopodial setæ form a large spreading tuft, but their tips scarcely reach beyond the end of the neuropodium; they are pale hay color, capillary, bipinnate, with the lateral processes alternating. Owing to a constant coating of foreign substances few details can be made out. Neuropodial setæ arranged in 3 supraacicular and 5 subacicular horizontal rows, amber-colored, relatively slender, with the smooth tips unusually long, and except on the most dorsal, exceeding the spinous portion in length; 4 transverse rows of spines on the ventralmost setæ, 9 on the dorsalmost.

Some color is retained in the elytra, which are yellow or brown, sometimes with an irregular greenish blotch surrounding a pale area opposite the point of attachment, the larger papillæ usually dark brown. The dorsal cirri and all cephalic appendages, with the exception of the palpi, have a broad zone of dark green pigment above the base, and a deeper but narrower one just proximad of the subterminal enlargement.

Lepidonotus cœlorus somewhat resembles *L. pleiolepis* von Marenzeller, but differs especially in the numerous spheroidal papillæ on the elytra and the more slender form and longer smooth tips of the neuropodial setæ.

Sagami Bay, 3,698, 153 fms., type and 8 other specimens; Suruga Bay, 3,707, 63–75 fms.

Lepidonotus (Hylosynda) vexillarius sp. nov. (Pl. XXIII, figs. 13, 14, 15.)

A rather slender species, measuring 23.5 mm. in length, 2.5 mm. in maximum breadth of body on the ventral surface of X, 4 mm. to ends of parapodia, and 5.5 to tips of setæ.

Prostomium slightly wider than long, sides smoothly convex without any prominent lateral lobes, posterior margin for its middle half continuous with peristomium, frontal sinus very shallow. Eyes 2 pairs, black, circular; the anterior larger and situated close to lateral margins at widest part of head; posterior on postero-lateral curvature, looking caudad, dorsad and laterad. Median tentacle arises from dorsal sinus nearly on the level of the dorsal surface of the prostomium; its ceratophore about $\frac{2}{3}$ as long as prostomium, white with a very conspicuous circular light brown spot covering most of the dorsum of the basal half; style scarcely three times as long as prostomium, of graceful form, tapering very gradually for the first $\frac{2}{5}$, then increasing even more gradually to near the end of the next $\frac{2}{5}$, then suddenly rounding off and bearing a delicate terminal filament, which makes up the final $\frac{1}{5}$; colors very pretty, rather dark brown at the base but fading gradually to white, with a deep brown, sharply-defined ring on the basal half of the subterminal enlargement, the remaining half and the terminal filament white. Ceratophores of lateral tentacles continuous with frontal processes of head, on the same level as the median ceratophore but only $\frac{2}{3}$ as long and little more than $\frac{1}{2}$ as thick; styles twice the length of the prostomium, of nearly equal diameter to the median tentacles, and terminal filament constituting nearly $\frac{1}{2}$ of their length; ceratophore dark brown, contrasting strongly with the colorless prostomium, a very narrow terminal white ring, styles colored as on median tentacle. Palpi reach to base of terminal filament of median tentacle, their bases broad, mostly concealed from above by the tentacular ceratophores and buccal parapodia, taper rapidly in a concave outline to a rather slender terminal half ending in a short filament; pale brown throughout.

Peristomial parapodia of the usual form. Tentacular cirri with styles similar to median tentacle in form and color, but with longer filament; the dorsal exceeds the ventral by the length of its filament and equals the median tentacle. There are 36 somites, exclusive of the pygidium, of which 35 are setigerous. Body smooth both dorsally and ventrally, the neural depression well marked and about as wide as the muscle ridges. No nephridial tubercles can be detected, but small dark spots in their usual position appear to be pores. Dorsum of the first 12 somites marked with brown spots of diminishing size, a small brown postanal spot, rest of body colorless.

The 2d parapodium (1st setigerous) is, as usual, shorter and its ventral cirrus longer than the others, but is peculiar in this species in that it is widely separated from the 3d and projects forward by the side of the mouth. Its ventral cirrus is quite distinct from the foot, and arises from a lobe which is carried forward to a position partly beneath the base of the palp, so that it actually arises between the tentacular cirrus and the palp. Typical parapodia moderately developed, with short, thick, obtuse neuropodia and fairly well-developed notopodia occupying the usual position; neuropodial aciculum especially stout, a slight angulation of the foot at the point of its emergence. Dorsal cirri with prominent postero-dorsal ceratophores and stout erect styles with a slight subterminal enlargement and flowing terminal filament; each marked at about the middle with a blackish-brown ring; if depressed they would reach just beyond the tips of the ventral setæ. Toward the posterior end they become more slender and lose the subterminal enlargement; the last 3 diminish rapidly in length, and are carried horizontally behind with the pair of anal cirri, which are similarly formed, but the largest appendage of the body, and in addition to the middle brown ring, have a narrow basal one.

The 18 pairs of elytra occur on II, IV, V, and every alternate somite to XXVII inclusive, then on XXVIII, XXX, XXXI and XXXIII. The first is orbiculo-quadrate, the next two slightly emarginate, the following ones obliquely ovate with the posterior internal margin more strongly convex than the antero-external; the point of attachment is a little caudad of the middle of the long axis and somewhat toward the antero-external border. A dense fringe of cilia extends over about ½ of the lateral margin of each, principally that part which projects freely at the sides; the entire dorsal surface is thickly covered with small angulated or prismatic papillæ with thickened cuticle, which are very densely aggregated in a narrow zone contiguous to the ciliated margin of the scale; 1 or 2 papillæ of the same form but 4–5 times as large may also be present. The 1st scale is peculiar in the character of its papillæ, many of which are tall, slender cones of various sizes, about five or six of them being very large, with a height almost equal to the short diameter of the scar. A few similar but smaller papillæ may occur on the 2d, 3d and last scales. Most of the elytra have merely a small but very conspicuous brown spot over the place of attachment, but the anterior ones are blotched, and the posterior speckled, with brown.

Notopodial setæ colorless, in 2 groups, the anterior of about six, very short, stout, strongly curved, with a short smooth tip and

strongly serrate convex margin, the teeth becoming smaller basally. Those of the posterior and more ventral group more numerous and about 4 times as long, relatively slender, pointed, straight or slightly curved, closely and doubly pinnate with short fine processes. Neuropodial setæ about 20, in 2 irregular vertical rows, rather stout, slightly bent but scarcely enlarged at the end, the long smooth, simple, slightly curved point nearly as long as the serrated portion, especially on the ventralmost setæ; teeth of terminal row very large and prominent, followed by from 5–9 rows of smaller ones diminishing toward the base.

Known from the type only, Totomi Sea, 3,729, 34 fms.

Hylosynda carinata sp. nov. (Pl. XXIII, figs. 16, 17.)

A large species here described from an anterior fragment, consisting of the prostomium and 26 anterior somites, with a length of 26 mm. and a breadth of 10.5 mm. between the setæ tips of X, where the body has a width on the ventral surface of 6 mm.

Prostomium very short, twice as wide as long, though this ratio may be due in part to contraction; anterior margin with a deep median sulcus, on each side of which are the broadly rounded lobes that pass into the bases of the lateral tentacles; lateral margins strongly convex, and posterior nearly straight. Eyes 2 pairs, black, circular; the anterior facing laterad and slightly dorsad at about the middle of the lateral faces; posterior about ½ the diameter of anterior, widely separated, but a little mediad of lateral, on the postero-lateral curvature of the prostomium.

Ceratophore of median tentacle arising from frontal sulcus, its length about equalling prostomium, stout, with a distinct terminal ring; style about 4½ times the length of the prostomium, slightly enlarged near the end, then suddenly contracted into a short terminal filament, which, with the distal portion of the enlargement, is white, the rest, including the ceratophore, coffee-brown. Ceratophores of lateral tentacles continuous with frontal lobes, ¾ the length of median ceratophore, and of the same shape and color; style similar to median style but more slender, and the relatively longer terminal filament reaching to the beginning of the white zone of the median style. Palpi a trifle longer than lateral tentacles, the base stout, their greatest diameter about ½ prostomium, the terminal half rather slender with a very short terminal filament; longitudinal ciliated ridges very strongly developed, 2 medial, and 1 each dorsal, lateral and latero-ventral; surface marked by irregular wrinkles which are of a much deeper brown color than the intervening areas. Pharynx stout, short, when protruded equal to

the prostomium and first 5 somites only; the jaws as usual, no median tooth; papillæ $\frac{9}{9}$ large, bilobed.

Peristomial parapodium reaches level of median tentacular ceratophore; styles similar to tentacles in form and color; the dorsal slightly longer, the ventral equalling median in diameter and slightly exceeding lateral in length. Ventral surface of body smooth, the neural groove well marked, and anteriorly equal in width to the lateral muscle bands. Nerve cords in contact throughout length. Some of the somites are filled with purplish eggs.

Parapodia prominent, but their length not exceeding $\frac{2}{3}$ width of body. Neuropodia taper toward slightly divided end which slopes dorsad to a broadly rounded tip; anterior lobe slightly larger and receiving the aciculum; a slight subterminal constriction. Notopodium small but prominent, on dorso-anterior face slightly distad of middle of parapodium, supported by a strong aciculum and bearing a few setæ. The dorsal cirri have very prominent ceratophores which are erect, curved laterad and supported on posterior margin of dorsal surface of parapodia; they resemble the tentacular cirri in form, color and size and fully $\frac{1}{2}$ of their length reaches beyond the corresponding setæ. The ventral cirri arise from low ceratophores about opposite the notopodia; the styles are slender and reach to the subterminal neuropodial constriction.

Only a few anterior elytra remain. They occur on the usual somites, and are delicate and membranous, but rather firmly attached. The 1st pair is missing; succeeding ones are broadly and nearly regularly reniform, with small elliptical areas of attachment so near to the lateral margins that fully $\frac{2}{3}$ of each scale is free medially, permitting them to overlap broadly. Margins smooth and non-ciliate. Dorsal surface punctate with distant sensory spots, and smooth except for an anterior border, broadest at the emargination, bearing small, low, faintly keeled crowded papillæ; most of the scales bear a prominent, more or less serrate crest extending from a point just over the medio-caudad margin of the scar toward, but not to, the posterior margin; frequently a similar but slighter ridge runs from the main one at an angle of 30°–45° laterad and caudad, or almost exactly in the direction of the dorsal cirrus of the following somite. The general surface of the scales is a delicate pale mottled brown, the crests a deeper brown.

Only 3 or 4 notopodial setæ occur in a small tuft which arises from the anterior surface of the base of the notopodium, and fails by a considerable distance to reach the end of the latter; they are rather stout for their length, slightly curved and tapering, but not sharp-

pointed, the outer half marked with transverse rows of rather coarse serrulæ. Neuropodial setæ in 2 or 3 vertical rows between ensheathing lips; pale amber color, free end enlarged for a greater distance on the ventralmost setæ, curved slightly dorsad, the tip bifid, the longer terminal process curved but not hooked, the ventral spur straight, large and continuous with the distal comb, transverse combs 12–17, and, with the exception of a few proximad of the enlargement, all with long teeth.

The station at which the type was taken is unknown; a fragment also occurs in the collections from Sta. 3,708, Suruga Bay, 60–70 fms.

Hylosynda magnacornuta sp. nov. (Pl. XXIII, fig. 18.)

A slender species described from a fragment consisting of the head and 26 somites.

Prostomium about 1½ times as long as broad, but the prominent muscular ridges which extend from its sides to the peristomial parapodia make it appear much broader, about twice as broad as long if these are included in the measurement. A median dorsal groove divides both anterior and posterior margins, but fades out at the vertex, anterior lobes broadly rounded, continuous with the bases of the lateral tentacles. Eyes 2 pairs, widely separated, small, black; anterior pair slightly the larger, lateral in position and nearer the anterior than posterior margin of the head, scarcely visible from above. Posterior pair smaller, entirely dorsal, separated from posterior border by about twice their diameter and from each other by about 7 times their diameter. Tentacle styles all lost, their ceratophores small, the lateral slightly more dorsal than the median and arising without any definite boundary from the anterior prostomial lobes; all sharply distinguished from the colorless head by thin deep chocolate bases. Palpi very large, about 6 times the length of the head and at thickest part more than ½ its width, the base constricted at its point of origin beneath the prostomium, gradually thickened to the end of the first fourth and then tapered to the long slender tip. Proboscis protruded, equal to head and 1st 11 somites; besides the dark brown paired long claw-like jaws, there is a small, low, conical, nearly black median dorsal and a similar ventral tooth; papillæ $\frac{8}{9}$, sharp-pointed, scarcely bilobed.

Tentacular cirri lost. Ventral surface of body smooth. Neural groove about ¾ the width of the lateral muscle areas anteriorly, diminishing to ½ posteriorly. The two halves of the nerve cord widely separated as far as somite XI or XII, then gradually approaching but not completely united within the limits of this specimen. Nephridial tubercles begin on V, soon becoming conspicuous and standing out

freely from the base of the parapodia. The last 7 somites present have their parapodia packed with whitish eggs.

Parapodia long, exceeding the dorsal width of the body except at its widest part, slender, tapering with a gentle curve to the slightly bilobed tip, the distal end oblique with a rather acute dorsal angle. The neuropodium, which forms the greater part of the parapodium, as just described, is divided by a vertical cleft into two plates, which are not so widely separated as in *Scalesetosus*, though that condition is approached anteriorly; anterior lobe the larger and receives the end of the rather strongly curved aciculum. The notopodium is a rudimentary nipple-like process which bears no setæ but receives the end of a slender aciculum. No important variations of the parapodia beyond the usual diminution in size occur toward the ends of the body.

Except for a minute regenerating one on XV all of the elytra have been lost.

The neuropodial setæ are perfectly colorless, delicate and brittle, but not especially slender in proportion to their length; the end rather abruptly enlarged, slightly curved and tapering to a bifid extremity, the terminal process of which is larger and slightly hooked; immediately proximad of the 2d one or spur are 9–14 short transverse combs, the teeth of which are minute distally but in the proximal rows exceed the diameter of the seta. There are no notopodial setæ.

Type, Sagami Bay, 3,698, 153 fms.

APHRODITIDÆ.

Lætmatonice producta Grube.

Sagami Bay, 3,698, 153 fms.

Lætmatonice producta Grube var. **benthaliana** McIntosh.

Suruga Bay, 3,726, 26 fms.; Totomi Sea, 3,729, 34 fms.; North Japan, 3,772, 79 fms.; North Japan, 3,774, 81 fms.

Lætmatonice filicornis Kinberg.

A single specimen of this Atlantic species occurs in the collection from an unknown station. The setæ differ somewhat from those of specimens dredged off the American coast.

Lætmatonice japonica McIntosh.

Sagami Bay, 3,698, 153 fms.; Sagami Bay, 3,738, 167 fms.

Lætmatonice pellucida sp. nov. (Pl. XXIII, figs. 19, 20.)

This species belongs to the *producta* group, and if McIntosh's views concerning the subdivisions of the latter prove to be correct may have to be considered as a variety merely. The largest specimen measures

30 mm., and the type 26 mm. long, and 11 wide between the tips of the parapodia.

Prostomium a flattened spheroid, slightly wider than long, with a slightly elevated median area which fades away anteriorly and widens posteriorly, where it is continuous with the peristomium. Ocular peduncles about $\frac{3}{4}$ as long as the prostomium, from the anterior face of which they arise, the ends enlarged and globular, the bases narrow and stalk-like; no distinct eyes, but a slight discoloration of the ends of the peduncles. Median tentacle with a thick swollen ceratophore which fills the space between the ocular peduncles, and about equals the prostomium in length; the style excessively slender, filiform, scarcely tapered, at least 9 times as long as the prostomium, its extremity slightly bulbous, with a subterminal constriction and a second more proximal enlargement. Palpi very slender, regularly tapering, whiplash-like, fully 15 times as long as the prostomium. Facial tubercle prominent, extending from the base of median tentacle into mouth, covered with conspicuous papillæ arranged in rows.

Peristomium short, coalesced with median portion of prostomium above, and united with somites II and III to form a broad quadrate postoral plate below. Setigerous somites 33, very indistinctly limited except at the bases of the parapodia; the surface quite smooth except on the postoral plate and the region immediately following, which are covered with globular papillæ of much smaller size than in many other species. The integuments are extremely transparent, so that the internal organs, and particularly the arrangement of the alimentary canal, nervous system and the masses of germ cells, can be clearly seen. The retracted proboscis reaches to somite XVI.

Parapodia of the usual form, with only a few very small spherical papillæ on the ventral surface; notopodia short, conical, directed nearly vertically on the scale-bearing, horizontally on the cirri-bearing somites; neuropodia long, very slender, and truncate at the end. Dorsal cirri of the same form as the median tentacle, equalling or exceeding the width of the body, and reaching far beyond the ends of the setæ. Ventral cirri short, about $\frac{1}{4}$ the length of the neuropodium, slightly tapering, blunt-pointed. Peristomial parapodia directed straight forward by the sides of the head, and nearly twice as long as the prostomium with its ocular peduncles. At its end a spreading tuft of capillary setæ arises from the inner side and occupies the space in front of the head, while from the outer face the tentacular cirri spring at right angles and then curve forward; they have form of the dorsal cirri, but are scarcely half their length, and much less than the median

tentacle. The first few neuropodia are shorter and stouter than the others, and the ventral cirri relatively longer; the last 3 parapodia are much reduced in size.

The elytra are fully exposed and, except the last pair, large, nearly elliptical, but with a slight emargination at the point of attachment on the lateral margin, from which point they extend inward and meet in the middle line but do not overlap in full-grown specimens; they are perfectly smooth, gelatinoid, pellucid and exhibit internally a peculiar fibrous structure closely simulating the appearance of the lacunæ and canaliculæ of bone tissue. Fifteen pairs occur on II, IV, V and succeeding alternate somites.

Dorsal felt fibers are entirely absent, and the spines are so few and small as to give to the species a characteristic unprotected aspect. The following is the arrangement of the setæ on a typical elytrophorous somite of the middle body region. The notopodial aciculum projects obliquely caudad and laterad, forming a pointed prominence, just within which a tuft of light golden spines spreads through the emargination of and over the dorsum of the elytron. These spines are few in number, and remarkably small and slender, both of which conditions may be due to the loss of the longer spines. They have the usual tapering, hollow stems, with the protuberances few in number and of unusually large size, the spear-head flattened, long and acute, with 2 or 3 additional barbs on one side and 3 or 4 on the other. On the ventro-posterior part of the notopodium is a tuft of delicate, flexible, finely striated, hair-like setæ which spread chiefly downward and outward over the anterior face of the succeeding parapodium. Neuropodium supported by a stout central aciculum about which are grouped 6 or 8 rather stout, rich brown setæ, with long hollow shafts striated both longitudinally and circularly, the outer ⅓ or ¼ bent, with a prominent spur at the convexity, beyond that tapering and provided with a single close row of very long hairs, the terminal ones of which envelop the slightly curved point. Cirriferous parapodia differ chiefly in the absence of dorsal spines and in having the capillary setæ coarser, stiffer, more numerous and spreading in a horizontal plain from a short line on the dorsal surface anterior to the dorsal cirrus. A tuft of such setæ occurs on the peristomial parapodia; on II the neuropodials are slender, and doubly fringed, and similar ones occur on III; those of IV, however, are typical.

Color pinkish.

Bering Sea, 3,784, 85 fms.

Aphrodita australis Baird.

This, the representative in the Australian seas of our well-known sea mouse, has not been recorded hitherto from Japanese waters.

Sagami Bay, 3,696, 501–749 fms., and 3,697, 120–265 fms.

Aphrodita japonica v. Marenz.

Von Marenzeller describes the ventral spines of his specimen as smooth, a condition which I have assumed to have resulted from the wearing away of the hairs present in all three of the "Albatross" examples. The palpi are also longer in the latter.

Sagami Bay, 3,698, 153 fms.; Sagami Bay, 3,704, 94 fms.; Suruga Bay, 3,713, 45 fms.

ACŒTIDÆ.

RESTIO gen. nov.

Both median and paired tentacles entirely absent; palpi well developed; ommatophores wanting or completely coalesced with the sides of the prostomium so that the eyes are sessile; peristomial palpi without setæ; setæ in general resembling those of *Eupanthalis*.

Restio ænus sp. nov. (Pl. XXIV, figs. 21–24.)

Represented by an anterior end consisting of the prostomium and 41 somites, probably the greater part of the worm, and measuring 35 mm. long, and 5.2 mm. in total width, which is remarkably constant.

Prostomium slightly wider than long, broadly bilobate anteriorly where a slightly median sinus divides it into two broadly rounded lobes from which the slides slope caudad to the somewhat narrower, straight posterior border. There are two pairs of eyes, of which the first are very large, black, cup-shaped, with a lens-like central thickening, and face directly forward, being situated on the anterior face of the prostomium close to the lateral angles. The posterior have a diameter of only ⅓ the anterior, are black, circular, without lenses, and are situated on the sloping lateral faces of the prostomium, from which they look outward and caudad across the pit to be mentioned below. From between the eyes of each side a translucent membranous process reaches laterad to, but not uniting with, the peristomial parapodia. There is not the slightest trace to be seen of median or paired tentacles, nor of the scars which they should leave if accidentally broken away, although the front of the head was examined with very great care under favorable conditions. The palpi have been lost, but very distinct scars remain beneath the anterior eyes on the extreme lateral part of the anterior

face of the prostomium; the distance between them is 1½ times their diameter.

Peristomial somite very distinct, its parapodia simple and extending straight forward by the side of the prostomium, with which they come in contact between the two pairs of eyes by means of their swollen anterior ends; elsewhere they are separated from the head, thus leaving a pair of deep pits between. Tentacular cirri lost, but leaving deep scars. Although the total width is nearly uniform, the body alone tapers continuously from the peristomium caudad, being very slender posteriorly; at VI it is 2½ times as wide as the parapodia are long; at XX they are about equal, and behind XXV the width of the body does not exceed ⅔ the length of the parapodia.

The parapodia following the peristomial exhibit a number of features of interest. The next six are broad and very short, and so close to the ventral surface of the body that the regular arched surface of the dorsum is scarcely broken by them. The next (VIII) is decidedly longer, and from this on to XXIV they continue to increase gradually in length but very little in breadth. Beyond XXIV they are stout and thick, and exceed in length the diameter of the body, with the dorsal and ventral surfaces of which they are continuous; their thickness in this region is a result of their distension by sperm masses. The anterior parapodia have the neuropodia broad and divided into pre- and postsetal lobes, of which the former is again divided into dorsal and ventral processes; the notopodium is altogether wanting on the 1st, but on the others is represented by a tubercle of increasing size, into which the aciculum enters. On somites IX to XX the notopodium forms a rather conspicuous broad flap, which passes down the dorsal half of the anterior face of the parapodium, and from behind which the capillary setæ arise in connection with the integumental attachment of the fiber gland. The dorsal angle of the neuropodium is prominent, rounded and achætous; the ventral angle is enveloped by the lower end of the postsetal fold. The notopodium becomes gradually reduced in size, and once more shifts to a dorsal position and loses its setæ; by XXV it is a mere dorsal papilla into which the aciculum enters and so remains to the end.

Only two elytra remain on the specimen, but at least 12 pairs of functional elytrophores are present on II, IV, V and every alternate somite to XXIII inclusive; posterior to this small elevations occur on every alternate foot, but it is doubtful if they bear elytra. The two scales present are small, not nearly meeting in the middle line, delicate, circular, low funnel form, the margins wrinkled; they bear no papillæ

nor cilia, but the interior is apparently divided by delicate plates into irregular polygonal cells, the largest of which are marginal.

Four forms of setæ occur on typical somites (X). Those of one kind are colorless, long, slender, curved and tapering, bear rather distant opposite pairs of slender awn-like spines, and have slightly enlarged bases not shown in the drawing (fig. 24); these are arranged in a single long vertical row which extends nearly half-way down the anterior face of the foot, and are attached to the notopodial fold which largely covers them anteriorly; they do not occur caudad of XX. Behind these is a second vertical row of stouter colorless spines, slightly enlarged subterminally and then tapering and fringed; few perfect examples of these have been found and none occur as far caudad as XXVI, and still farther back the first-mentioned capillary setæ are also wanting. A third vertical row contains setæ of two kinds and, with certain changes in number and arrangement, is constant on all parapodia. Five or six pale yellow, short, stout setæ occupy the dorsal end of the bundle in more anterior, and the middle in more posterior somites; they present a subterminal enlargement, and a peculiarly roughened slightly hooked tip continued into a densely hairy filiform appendage and guarded by a dense brush of very stiff hairs; usually the capillary tips and much of the guard have been worn away, and possibly the tip is normally absent posteriorly. Ventral to these in anterior, and both ventral and dorsal in posterior, somites is a group of colorless more slender setæ, with broad lance-shaped ends and transverse rows of fine bristles which become larger on the dorsal side.

Besides the true notopodial and neuropodial acicula, fiber glands are found in relation to all parapodia from somite IV to the end of the body, although the chitinoid rope is conspicuous only between X and XXV. In structure they resemble very closely Eisig's figures of *Polyodontes*, that of XVI, for example, consisting of a dense strand of chitinoid fibers of iridescent brassy color, enveloped in a cellular sheath and measuring 15 mm. long by .3 mm. in diameter. The free internal end gradually tapers, the cellular sheath at the same time becoming thickened and finally terminating in a slightly bulbous mass of cells, from which the gradually forming fibers may be traced. The outer end presents a rather considerable spherical enlargement of about twice the diameter of the strand and composed of a dark granular matter (cells?). It is attached to the integument at the bottom of the postnotopodial groove from which the most anterior row of setæ arises, and when forcibly pulled away entire some of these come with it. The strands pass into the cœlom, the anterior ones usually arranged horizontally by the

side of the pharynx, the smaller posterior ones coiled in about 2 turns in the base of the foot.

Type only, Suruga Bay, 3,707, 63 to 75 fms.

SIGALEONIDÆ.

Thalanessa oculata McIntosh.

Sagami Bay, 3,702, 31–41 fms.; 3,704, 94–150 fms.

Leanira areolata McIntosh.

Sagami Bay, 3,695, 3,696, 3,698, 153 to 749 fms.

Leanira japonica McIntosh?

An incomplete specimen is doubtfully referred to this species, from which it differs considerably in the shape of the elytra.

Totomi Sea, 3,731, 55–65 fms.

EUPHROSYNIDÆ.

Euphrosyne superba v. Marenz.

The single example which represents this species has only 7 pairs of branchiæ to each somite.

Suruga Bay, 3,717, 63–100 fms.

AMPHINOMIDÆ.

Chlœia flava (Pallas) De Blain.

This splendid annelid was collected in some numbers in 8 fathoms at Tatyama, Japan.

PHYLLODOCIDÆ.

Eumidia cæca sp. nov. (Pl. XXIII, figs. 1, 1a.)

A complete worm has 187 segments, and measures 88 mm. in length and 4 mm. between the tips of the parapodia at the middle of the body. Somewhat depressed, tapering about equally from the middle to both bluntly pointed ends.

Prostomium as viewed from above nearly circular, the postero-lateral region somewhat encroached upon by the sides of the peristomium. Eyes absent, but a dark spot near the center of the dorsal surface. Frontal tentacles short, less than the transverse distance between them, stoutly fusiform with the tip acute, those on each side very close together, the ventral somewhat more caudad and about ½ longer than the dorsal. Median tentacle very short, at extreme posterior margin of peristomium. "Palpi," short lobes bounding the mouth laterally and apparently connected with the peristomial somite.

Peristomium of two united somites, about twice the width of the head and equalling it in length, encircling the prostomium as a promi-

nent fold which encroaches on it laterally, but emarginated dorsally to accommodate the median tentacle. The anterior half of the peristomium bears the first tentacular cirrus and more ventrally the so-called palpi. Tentacular cirri rather short and stiff, with very short ceratophores; the styles of the first conical, obtuse, with a length scarcely exceeding the width of the prostomium; those of 2d peristomial somite lanceoloid, acute; the dorsal one 3 times the length of the 1st and reaching to somite X, the ventral $\frac{2}{3}$ length of latter and reaching to VII; tentacular (dorsal) cirrus of 3d (1st setigerous) somite equal to preceding dorsal tentacular cirrus, and reaching to XI. Remaining somites well marked, strongly arched above, flattened below, increasing in length to middle of body. Caudal end blunt, without cirri in this specimen. Almost entire body, except a few anterior somites, filled with eggs.

Parapodia uniramal throughout, all parts more or less foliaceous, least so anteriorly. Neuropodium flattened antero-posteriorly, the presetal lobe much the larger, broadly rounded and divided by a narrow cleft at apex, postsetal lobe very short. Ventral cirrus leaf-like, broadly ovate, the apex obtuse, much larger than neuropodium, posteriorly overlapping and extending beyond it, obliquely attached by basal half of dorsal margin to a flattened lobe-like process from the ventral side of the neuropodium. Notopodial cirrus reniform, with a deep sinus; long diameter, which is directly oblique to longitudinal axis of body, twice short diameter; posteriorly they are more rounded, overlapping from before backward, covering parapodia and leaving the dorsum of body only exposed; ceratophores very broad, flattened, slightly curved dorsad, with a wing-like ventral process which probably represents the notopodium, but receives no aciculum. Form of parapodia very constant throughout entire length of body, the anterior ones becoming smaller and the last three at the caudal end simplified.

Setæ all of one kind, arranged in a broad fan-shaped fasciculus, colorless, compound, shaft very gently curved, slightly enlarged at end; socket narrow, its wall deeply cut away on one side and slightly thickened at that point to form a seat for the slender base of the appendix, elsewhere high and provided on each side with one large and three or four smaller teeth; appendix very delicate, elongate, attenuate, normally straight, though often curved in preparations, the back thickened, the edge knife-like and rather remotely serrulate with small short teeth.

The color is partially preserved; a rather broad band equal to $\frac{1}{4}$ width of back, of reddish-brown, marks the median dorsal region, be-

coming of a richer more purplish color anteriorly and there terminating abruptly in a spot which includes the entire dorsum of the 7th to 10th setigerous somites. A spot of the same brown color occurs on the medial half of each dorsal cirrus. Otherwise the entire body and especially the cephalic region is of a brilliant white.

Type specimen only; Sagami Bay, 3,702, 31–41 fms.

Phyllodoce grœnlandica (Oersted) Mgrn.

A small example of 80 mm.

Suruga Bay, 3,707, 63–75 fms.

NEREIDÆ.

Nereis pusilla sp. nov. (Pl. XXIV, figs. 25, 26, 27.)

The type specimen, consisting of 50 somites, measures 20 mm. long and 2.2 mm. between the tips of the parapodia at the widest point.

Prostomium longer than wide, the preocular portion little narrower than ocular, anterior margin broad, truncate, lateral margin little excavated for palpi. Eyes two pairs, large, conspicuous, black, apparently posterior only with cuticular lenses; posterior on extreme hinder margin of head, circular; anterior somewhat larger, more widely separated, at bases of palpi, elliptical. Frontal tentacles widely separated at base, conical, length much less than ($\frac{2}{3}$) distance between posterior eyes. Palpi prominent, as long as prostomium, terminal piece short, conical.

Peristomium $\frac{1}{2}$ prostomium above, $\frac{3}{4}$ as long laterally. Tentacular cirri rather short, slender, non-articulate; posterior dorsal reaches to V, anterior dorsal to IV, and both ventral ones to III. The following somites are long, the anterior ones equalling the peristomium in length.

Parapodia slender and very prominent, after the 12th about equalling the width of the body. The 15th parapodium has the base about as long as deep, the notopodium larger than neuropodium, which it slightly overlaps anteriorly; notopodium divided into two long, pointed, conical, dorsal to ventral lobes, between which the setæ arise, and a very slightly shorter slender, presetal lobe; the notopodial cirrus very slender, arising from the swollen basal $\frac{1}{3}$ of the dorsal notopodial lobe, and reaching scarcely beyond the tip of the latter. Neuropodium consisting of an elongated conical ventral lobe and a slender setigerous lobe which divides at the end into a short broad presetal and a very long slender postsetal process, the latter extending slightly beyond any other portion of the foot; neuropodial cirrus small and slender, its origin well separated from base of neuropodium, and its tip failing to

reach the middle of the ventral neuropodial lobe; the slender black acicula are parallel, the neuropodial slightly the longer.

Anteriorly the parapodia become shorter and on the first and second the notopodial setigerous lobe is lacking, the notopodial cirrus becomes relatively shorter and the neuropodial longer than on the typical foot, so that the ventral is the longer on the first and has its base constricted and the cuticle in that region much thickened. Posteriorly all of the lobes become even more slender and elongated, the neuropodium and notopodium are even more closely appressed, the neuropodial cirrus more widely removed and so much diminished in size that it scarcely reaches to the base of the ventral lobe, while the dorsal cirrus retains its characteristic length.

Setæ all compound, nearly colorless and very transparent. Notopodial all alike, the stems slender and very regularly camerated, the terminal socket symmetrical, blade remarkably slender, with capillary tip and short fine hairs on the concave margin of the basal $\frac{2}{3}$; those in the dorsal part of the vertical row with much longer blades than the ventral ones; similar setæ occur in the dorsal and posterior part of the neuropodium. In the ventral region of the neuropodium are a few short-bladed compound setæ; their stems rather stouter but camerated in a similar regular manner, the end more enlarged, the socket oblique, the long limb of its margin receiving the septate cavity which is here divided by a longitudinal partition; the blade hooked, guarded and provided with very stiff hairs directed distally. Several stouter setæ of this type occur in the anterior dorsal part of the neuropodium, but, except for their slightly shorter blades, they differ in no noteworthy manner from those just described.

Exposed portion of maxillæ brown, relatively short, broad, acute, the edge with 3 teeth in the basal half separated by a wider interval from a 4th double tooth near the apical fang. Paragnathæ brown, small, conical, all separate, the posterior ones in each group somewhat larger; group I, 5 in longitudinal series, the first minute, increasing in size caudad; II, oblique elliptical areas, in 3 ranks, anterior lateral of about 4, very small, middle of 6 larger, posterior internal of 5 still larger; III, a small longitudinally elongated group of 10–12; IV, nearly circular areas of 18–24; the basal circle absent.

Head and anterior segments delicate rose-red, brightest on head and gradually fading posteriorly. The specimens are immature, but differ from all described species, especially in the character of the paragnathæ and feet.

Two specimens, Suruga Bay, 3,707, 63–75 fms.

Nereis paucidentata sp. nov. (Pl. XXIV, figs. 28, 29, 30.)

The type and only specimen is complete but in several pieces, which have a total length of 95 mm., with a maximum width of 6 mm. at XV. There are 118 fully developed somites and a small caudal tip of 6 regenerating ones.

Prostomium slightly broader than long, broadly rounded anteriorly, where it is about ½ the greatest breadth across the anterior eyes, broadly excavated at the sides for the bases of the palpi. Eyes 2 pairs, both with cuticular lenses, large, the anterior slightly the larger and farthest apart. Frontal tentacles short, awl-shaped, about equal in length to the distance between the posterior eyes. Palpi reaching to tips of frontal tentacles, the bases stout and swollen, the styles nearly spherical, knob-like, partly retracted into ends of bases, and about ½ diameter of these.

Peristomium dorsally nearly ½ length of prostomium, its enlarged lateral part ¾ as long. Tentacular cirri rather short, the styles more or less distinctly articulated, posterior dorsal reaching VI, anterior dorsal V, posterior ventral III and anterior ventral II.

The form of the somites presents nothing characteristic and the caudal cirri are wanting.

The parapodia resemble those of *N. dumerilii*, but the lobes are more prolonged, and the dorsal cirrus has a more basal origin throughout the series. The typical foot presents four principal elongated subequal lobes, with a slender notopodial cirrus, about twice the length of the lobes, arising from the swollen region near the middle of the dorsal margin of the foot, and a neuropodial cirrus, about equalling the ventral lobe, from which it is separated by a short interval. The neuropodium consists of a rather truncate setigerous lobe, bearing a broad presetal process, into which the aciculum enters, a much longer and more narrow conical postsetal lobe, and a slender, conical, ventral lobe. The notopodium is separated from the neuropodium by a deep narrow cleft, and consists of 2 slightly divergent, elongated, conical, dorsal and ventral lobes, between which the setæ arise, guarded by a shorter, flatter, presetal process, which is more closely connected with the ventral lobe. Anteriorly the notopodial presetal process diminishes in size and disappears entirely, with the setæ, on the second foot; the setigerous lobe of the neuropodium undergoes little change, but the ventral lobe becomes large and thick, and more closely united with it. The first and second parapodia have the dorsal non-setigerous lobe only of the notopodium, and the ventral lobe of the neuropodium considerably larger than the setigerous lobe and broadly rounded at

e end; the dorsal cirrus is 1½ times the length of the notopodium id the ventral slightly longer than the neuropodium. Posteriorly the otopodium increases relatively in size, giving the entire parapodium a oblique aspect, at the same time becoming much more vascular and ontractile, which greatly affects the relative proportion of parts in eighboring parapodia. Otherwise they undergo little alteration.

The setæ are all compound and three forms occur. The notopodials re all similar, with slender, strongly and closely camerated shafts, ymmetrical sockets and long, straight, slender, tapering and strongly ringed blades. In addition to the setæ of the notopodial kind which re the most numerous dorsal to the aciculum of the neuropodium, the atter bears two other forms of compound setæ. In the ventral part f the foot are some rather stouter ones, in which the shafts are camrated and the sockets oblique, the fringed blades much shorter, broader, ooked and guarded at the apex. Two or occasionally 3 much stouter eep yellow setæ project stiffly from a point just dorsad of the aciculum; the camerated interior of the shaft is marked by a central line. erhaps due to perforations in the septa, its end bears a shallow blique socket, and the very short blade, which is very seldom present, strongly hooked, striated, guarded and furnished with a marginal inge of long hairs.

Maxillæ brown, broad, not especially acute, abruptly oblique at id, each with 8–9 teeth in addition to the terminal fang, from which ley are separated by a short interval. Paragnatha almost obsolete; axillary ring: I, wanting; II, 2–4; III, 1; IV, 2; a very minute one 1 each side between III and IV; basal ring represented by three small eth arranged in an arc on the ventral side; all are small, low conical nd brown.

One specimen, type, north of the Aleutian Islands, 3,785, 270 fms.

ereis pelagica Linn.

Sagami Bay, 3,700, 63 fms.; Totomi Sea, 3,729, 34 fms.

NEPHTHYIDÆ.

ephthys brachycephala sp. nov.

None of the specimens is complete, the type and most perfect one aving 60 segments and a length of 64 mm., the maximum breadth etween the tips of the parapodia being 4 mm. at X. Body relatively ender, not depressed, anteriorly nearly round, but venter somewhat attened; posteriorly nearly quadrate.

Prostomium very short, twice as wide as long, deeply sunken (about of its length) in peristomium, roughly oblong, with anterior angles ightly truncated, lateral margins slightly convex, anterior gently

concave, and posterior straight. Eyes absent. Tentacles very short, the lateral slightly the larger and about $\frac{1}{3}$ length of prostomium, both pairs borne close together on the truncate lateral angles, directed nearly straight forward, but slightly divergent.

Parapodia short, especially anteriorly, the two rami widely separated, least so in the middle region, where the branchiæ are highly developed. Neuropodium and notopodium about equally developed throughout, the former directed laterad, simple, truncate, conical; with slight acicular lobe and circumsetal collar, but no distinct lamellæ; cirrus very short, thick, conical, arising from ventral side of neuropodium close to base. Notopodium directed somewhat obliquely dorsad, also of simple, short, truncate, conical form, without lamellæ; acicular lobe well-marked and notched at end; circumsetal collar oblique, its posterior portion high, the anterior very low. No dorsal cirrus, but a special cirrus of short thick form on ventral side of notopodium, in the branchiate segments closely connected with the external side of the base of the branchial stem.

Branchiæ begin on V, as a minute process on the ventral and internal side of the cirrus; this increases in size and develops dorsal and ventral wings, which assume the characteristic form by XV, though continuing to increase in size for some segments beyond. In its typical development the branchia is extremely like *N. phyllobranchia* McIntosh, but the shape of the prostomium readily distinguishes the two species; the branchia is a large wrinkled leaf-like structure, through the middle of which runs a thick tapering midrib, the tip of which projects slightly, and from which vessels pass into the expanded portion. When best developed it occupies most of the space between the two rami. Posterior to XXXV the branchiæ undergo reduction until the much shortened midrib alone remains, bearing a minute process, probably the cirrus, on the dorsal side of its base.

The setæ are almost entirely destroyed, but their dark-colored bases remain to indicate their arrangement. Anteriorly they are disposed in both rami in rings around the acicula as centers, the posterior semicircle being composed of large, the anterior of small, setæ which soon disappear, leaving only the posterior arc in parapodia farther caudad. None of the setæ are complete, but enough may be seen of those of the anterior semicircle to show that they are camerated and very small and delicate. Nothing whatever can be determined of the characters of the posterior ones. A single slightly brownish, acutely pointed, stout aciculum supports each ramus.

Sagami Bay, 3,695, 175–190 fms.

Nephthys ciliata (Müller) Rathke.

This species was dredged in large numbers in Avatcha Bay, Kamchatka, in 12 to 15 fathoms, on a bottom of stiff green mud. A specimen from north Japan (3,775), taken in 57 fathoms from a bottom of similar character, has much longer setæ and larger cirri.

EUNICIDÆ.

Eunice northioidea sp. nov. (Pl. XXV, figs. 36, 37, 38.)

The type is in two pieces, probably representing the greater part of the worm, and together including the head and 86 somites measuring 58 mm. in length and 3.5 mm. wide. The body is very little depressed and of nearly uniform diameter throughout the region represented, the dorsum very high and convex, the venter nearly flat, with a deep neural groove. Owing to a rather strong forward tendency of the anterior feet this end of the worm presents a slight resemblance to *Northia* and its allies, which is heightened by the pearly-white color of the greater part of the dorsum of VI.

Prostomium strongly retracted within peristomial fold, concealing about one-half of its length, which is 1½ times the length of the peristomium, shape about as in *E. mucronata*, the frontal tentacles much less divergent than in *E. quinquifida*, their terminal joint rudimentary. Eyes one pair, large, brown, below base of inner and behind outer lateral tentacles. Tentacles strongly and nearly regularly beaded in the terminal portion, the constrictions becoming fainter toward the base. In the condition presented by this specimen the median and inner lateral tentacles are subequal, the former touching VIII, the latter reaching into VII, and the outer laterals just touch IV. The basal articulations of all are rather more distinct than in the other species herein described.

Peristomium with a wide free anterior fold above, its longest part not lateral, as usual, but ventral, owing to the unusually large size and prominence of the mandibular lobes. Second somite longest dorsally, where it equals ⅓ the peristomium; its cirri long, slender, beaded, reaching tip of head anteriorly, and to middle of VI posteriorly.

Parapodia essentially as described for *E. quinquifida*, but more ventral in position; dorsal cirri about as long as in that species, but more distinctly articulated, the sense-organ moderately developed; pigmented spots at bases of both dorsal and ventral cirri.

Branchiæ begin on IV as a slender process, which by VIII nearly equals the dorsal cirrus on one side, while on the other it is bifid and nearly as long; they are trifid on both sides on XI, quadrifid on XV

and so continue, with occasional variations to three divisions, to XXII on one side, and XXIII on the other, then again trifid to XXVII, bifid, or occasionally trifid, to XXXII; from this point a single filament, which is at first larger than, but gradually decreases until it only equals, the dorsal cirrus, continues to the posterior end of the piece. Although the same bifurcate mode of branching as in *E. quinquifida* occurs, the aspect of the gills is totally different; the branches are thicker, stiffer and, instead of bending toward the middle, stand erect, but the parapodia are placed so low down that they scarcely arise above the level of the back.

Setæ fewer than in *E. mucronata*, generally stouter and more regularly arranged in horizontal rows. All are colorless.

Compound setæ with shafts thickened gradually at the end for a distance considerably exceeding the length of the appendix, here with strongly marked oblique striations and the dorsal margin distinctly denticulated over a considerable distance; appendix short, the length 4–6 times its width, with a well-marked subterminal constriction and a bifid tip, the terminal tooth slightly hooked, the other broad, straight, acute; guard broad, without mucronate tip, closely following outline of terminal tooth, beyond which it extends slightly on the dorsal side. As usual the appendages are relatively longer on anterior and shorter on posterior parapodia.

Capillary setæ about $\frac{1}{3}$ longer than the compound, rather strongly curved, and tapering only in the terminal $\frac{2}{3}$ of the exposed portion, but then to an excessively acute point.

Spatulate or paddle-shaped setæ rather more than $\frac{1}{2}$ length of capillary setæ, by which they are concealed from above; situated caudad of the acicula and ventrad of the capillary setæ, tapering gently to little expanded ends which have about nine points, both marginals being produced, but very unequally, the anterior one apparently always the longer.

The acicula are deep brown, practically black, in color, and opaque except at the smaller ends; the ordinary ones are two in number, subequal, bluntly tapered, and slightly curved at the end. In the posterior somites, beginning at about XL, is a single ventral uncinate aciculum of rather strongly sigmoid curvature and with a bifid hooked end. They are always thickly incrusted with a reddish-ocherous deposit, the removal of which destroys the guards.

Jaws hoary brown, the thin plates yellow; maxillæ stout, strongly hooked and curved ventrad near the broad base, which is provided with a prominent tubercle for muscular attachment; carrier broad, not

constricted. Next pair of dorsal jaws triangular with the two posterior angles prolonged, and the anterior angle provided with a strong, somewhat hooked tooth supported by a small anterior one, and succeeded on the left, which is the larger of this pair of jaws, by four, and on the right by three, somewhat unequal teeth, while the remaining posterior third of the medial side is edentulous. The anterior group of dorsal jaws includes four pieces on the right, and three on the left side arranged in arcs; the most external on each side is a small toothless plate; the next bears one tooth. The next, which is the most anterior of the group, is supported by a small, deep brown plate with a larger thin yellow extension; on the right side it bears 8 teeth, and an internal slightly serrated ridge; on the left it is much shorter, and bears but 6 teeth, but is supplemented by the fourth jaw plate, which fits inside of its posterior end, is of an elongated crescentic form and bears about 12 teeth. The mandibles are remarkably prominent, the two halves freely movable on each other, the whitish calcareous pieces less than ½ the length of the slender yellow carrier, strongly divergent, irregularly oval in form, with four ridges and as many obscurely indicated marginal teeth, the anterior angle prominent, almost hooked.

Suruga Bay, 3,718, 65 fms.

Eunice vittata Della Chaije.

Quite common at station 3,707 in Suruga Bay in 65–75 fms.

Eunice quinquifida sp. nov. (Pl. XXV, figs. 39, 40, 41.)

The single specimen representing this species is incomplete, consisting of the head and 56 somites measuring 45 mm. long and 4 mm. between the tips of the parapodia.

Prostomium about twice as wide as long, very deeply cleft in front and the frontal tentacles so strongly divergent that in ventral view it appears to be formed of two broadly pyriform halves connected at their apices by a rather narrow posterior band, terminal pieces of frontal tentacles even smaller than usual. Eyes, 1 pair, large, brown, in the usual position and largely concealed by the free anterior border of the peristomium. Tentacles all irregularly and boldly articulated, rather short, tapering; the median evidently imperfect, the inner lateral reaching to VIII, and the outer lateral to III. Peristomium very long, especially on the sides where, with its broad anterior lobes, it much exceeds the prostomium which it dorsally encloses as far as the bases of the tentacles in a prominent fold uniting with the sides of the prostomium below the eyes as far forward as their anterior borders.

The second somite is very short, not more than ⅓ of the peristomium,

from which it is imperfectly separated laterally, and only about $\frac{1}{3}$ as long as somite V; tentacular cirri tapering, rather faintly articulated in the terminal half, reaching anteriorly to the cephalic margin of the peristomium and posteriorly to V. Body little depressed, strongly convex even in the branchial region, and with a very strongly marked neural groove. Length of somites, which are very distinct, increases to VI, which is three times as long as II, undergoes little diminution in the branchial region, but increases somewhat in the region posterior to the principal branchiæ.

Parapodia similar in form and variations to *E. mucronata*, but the neuropodium rather larger and the whole more prominent. The notopodial cirri are remarkable for the very large size of the basal portion, which much exceeds the entire neuropodium in size in the middle region of the body. Notopodial cirri relatively short, about twice the length of the neuropodium to which they are attached, scarcely reaching half-way to the dorsimeson, tapering, faintly articulated at least anteriorly, the basal sense-organ very small; a conspicuous bilobed brown spot occurs just within the body at the base of the dorsal cirrus.

Branchiæ appear suddenly as two filaments on the left side of IX and 3 on the right side of X, increasing to 4 on XI, 5 on XVIII and XIX, which number is maintained to XXXV and XXXVII, with an occasional variation to 4, especially on the right side, then 4 and 3 to XLI, and 2 for the remainder of the piece. Even when best developed the branchiæ of the two sides are separated by fully half the width of the back. Their aspect is very different from the branchiæ of *E. mucronata;* the stem arises in the same way and curves mediad over the back, but it is angulated, and the branches, instead of arising erect, dicotomose nearly regularly with it and curve parallel to it toward the median line.

The number of setæ is moderate, the compound and capillary being about equal and rather definitely arranged in rows. Compound setæ very pale yellow, rather stout, the terminal portion of the shaft thickened for a distance of 5–6 times the ordinary diameter, with axial striations and marginal denticulations for a long distance; appendage relatively short, less than the enlarged end of shaft, the tip strongly hooked and prominently bifid; the guard broad, extending a short distance beyond tip of appendage, striated and marginally denticulated.

Capillary setæ colorless, gently curved like an italic *f*, slightly enlarged about middle with a narrow denticulated wing, and tapering to a fine point in the terminal $\frac{1}{3}$. Paddle-shaped pectinate setæ wider than in other species of *Eunice* herein described, with about eleven

eeth, the marginal ones of which are only slightly and subequally pro- onged.

Acicula black and opaque; ordinary kind two or occasionally three, apering rather suddenly to a blunt, curved tip; posterior ventral ones ather strongly sigmoid, the tip hooked, bifid, with a broad, well- narked, striated guard.

All of the jaws, except the anterior lateral, which are brown, have a eculiar hoary appearance. Mandibular carriers slender, about 2½ imes as long as the calcareous plates; the latter roughly triangular, he posterior internal angle broadly rounded, the most acute angle nterior and somewhat divergent; medial side shortest, convex, with small process which joins its mate; anterior margin concave and osterior convex; 2 anterior teeth besides the angle.

Maxillæ slender, the carrier small and without a constriction. Pos- erior lateral plate triangular, with a transverse joint about the middle, ith 5 teeth and a posterior compressed margin on the left, 6 teeth and longer toothless margin on the right. Anterior group of 2 right and left jaws; the dorsalmost rather large, divided into 2 in each case and earing a single rather broad tooth; the second long on the right, with l fine teeth, shorter on the left, with only 5; unpaired left jaw with teeth.

Sagami Bay, 3,698, 153 fms.

unice mucronata sp. nov. (Pl. XXV, figs. 42–45.)

Size small, the largest entire worm having a length of 110 mm. clusive of the cephalic and caudal appendages, but other incomplete ecimens indicate a length up to 150 mm., and have a width at the id of the anterior fourth of 4 mm. Form moderately slender; num- er of segments about 125.

Prostomium slightly broader than long, the length about equal to the eristomium; deeply bilobed anteriorly, the frontal tentacles prominent nd widely divergent below, the median sulcus deep and wide, extend- ig from a point between the external paired tentacles on the dorsum early into the mouth ventrally and posteriorly, palpal styles very hort, scarcely elevated above the basal lobes from which they are lelimited by a shallow encircling groove. Eyes 1 pair, large, purple, n posterior margin of head, just ventrad of inner paired tentacles, nd in the preserved material partly concealed by the anterior border f the peristomium. Tentacles all long, slender, tapering, and not, r, only very faintly, articulated, the median reaching to XIII, the nner lateral to XI, and the outer lateral, which are sometimes more listinctly articulated than the others, to IV or V; all are very fragile

and consequently often injured and imperfect; inner laterals arise just dorsad of the eyes, outer laterals just cephalad.

Peristomium about as long as the prostomium laterally, but elsewhere shorter; dorsally it presents a shallow bay affording an inset for the bases of the median and inner lateral tentacles, laterally a subocular lobe which is united with the prostomium and partly conceals the eyes, and ventrally a pair of lobes which conceal the mandibles and are separated from one another and from the lateral lobes by emarginations. Tentacular cirri long and slender, reaching slightly beyond the anterior extremity of the palpal lobes and, when reflexed, caudad to somite VII.

The second somite is about $\frac{1}{3}$ the lateral length of the peristomium, and $\frac{3}{4}$ the length of somite V, to which the lengths of the somites increase, beyond which they decrease through the branchial region, and then regain their maximum size, which is retained until they finally fall off to the caudal end. The body as a whole is somewhat depressed, most so in the branchial region, strongly convex dorsally in the prebranchial and caudal regions, but ventrally flattened throughout, with a strongly marked neural groove. The two long tapering caudal cirri equal the last 9 segments in length.

The first pair of parapodia are on a level with the ventral surface, and succeeding ones gradually rise until the normal position about midway between the dorsum and venter is attained by X or XI, and maintained throughout the branchial region and beyond; then they sink again to the ventral level posteriorly. The typical structure is reached at about the 5th or 6th parapodium. Neuropodium short, little tapered, truncate and somewhat bilobed. Neuropodial cirri with enlarged, tumid bases about equal to the neuropodia, bearing small lobe-like terminal pieces about $\frac{1}{3}$ as long. Notopodial cirri slender, with a slight sensory swelling on the ventral side near the base, about 3–4 times the length of the neuropodium and nearly long enough to reach the median line of the back. The first parapodium consists of a minute setigerous lobe, a long notopodial cirrus reaching the anterior border of the peristomium, and a much stouter basally swollen neuropodial cirrus of about half this length. Toward the posterior end the parapodia become more tapering in continuation of the body outlines, and scarcely project from the surface; the neuropodial cirri lose the basal enlargement, taper regularly, become more prominent and assume a more caudal position with relation to the foot; the notopodial cirri become relatively shorter, the extreme posterior ones being about twice as long and half as thick as the ventral, and the sensory elevation more prominent.

Branchiæ appear and cease abruptly, occupying somites V to XXXVI, caudad of which they do not ordinarily occur. Each arises in common with a notopodial cirrus from a very short base, and the main stem curves gently over the back to meet its fellow of the opposite side at the middle line; the stem tapers and the erect pinnæ arise from it separated by intervals of ½ their diameter; they are of unequal length, the middle ones about equalling the notopodial cirrus, and the end of the stem bends upward as the last branch. At both ends of the branchial region the number of pinnæ is subject to considerable variation, the following figures being the average of 3 specimens upon which all were counted. They appear as a small process on V which elongates on VI, become trifid on VIII, and have 4–6 branches on IX, 7–9 on X, 12 by XIV, 14 at XVIII or XIX, which number is retained, occasionally rising to 15, to about XXX or XXXII, and then falls rapidly to 10, 7, 5 and none on successive somites.

Typical parapodia bear setæ of three kinds, all slender, delicate, and colorless. First, compound setæ: numerous, in a fasciculus on the ventral part of the neuropodium; stems curved, with a short abruptly enlarged end striated axially and serrated on one margin; appendage slender, elongated (most so anteriorly), with the end weakly hooked and faintly bidentate, the margin finely serrated, the guard greatly prolonged in a mucronate tip equal to ½ or more the length of the appendage. Second, very slender elongated capillary setæ arranged in a row which extends around the dorsal and posterior sides of the fascicle of compound setæ; these taper gently and uniformly, and appear to be nearly or quite smooth. Third, paddle-shaped pectinate setæ in a small fascicle just dorsad of the acicula, very delicate and terminated by 9 or 10 points, of which the 2 marginal ones are somewhat unequally prolonged; these are very inconspicuous, being concealed by the bases of the capillary setæ, and the flattened ends are placed horizontally.

The ordinary acicula are pale yellow, 2 in number, 1 much stouter, simple, tapering, with blunt slightly bent tips.

Beginning with the mid-branchial region and continuing caudad 1 or 2 additional sigmoid uncinate acicula with guarded, hooked, trifid tips appear on the ventral margin of the neuropodium.

All jaws pale brown except the white calcareous mandibular plates. Mandibular carriers broad anteriorly, but tapering rapidly to very slender divergent posterior ends, about twice the length of the calcareous plates; the latter somewhat triangular, the angles anterior, postero-medial and postero-lateral, inclined to the carrier at an angle of about 45°, but the anterior angle bent forward so as to lie in a longitudinal

plane; besides the anterior angle a single obscure tooth about the middle of the antero-medial side. Maxillæ of the usual form, the carrier minute, the 2 halves together scarcely exceeding in width the base of the maxillæ proper, and their length only ¼ that of the latter. Posterior lateral plate triangular with unusually long median side bearing about 10 conspicuous sharp teeth. Two anterior right, 3 left jaws; the first with a single tooth, the 2d with 11 right and 8 left, the 3d left with 8 teeth occupying its entire margin.

Very common in Sagami Bay, 3,698, 153 fms

Eunice gracilis sp. nov. (Pl. XXV, figs. 46, 47, 48.)

A rather slender-bodied species with parapodia of greater length than usual. The type consists of 110 somites, is 49 mm. long and 4 mm. wide to the tips of the feet.

Prostomium about equal in length to peristomium, into which it is less retracted than usual, anterior sulcus not quite reaching to median tentacle on dorsal surface, but passing into mouth ventrally. Frontal tentacle prominent, divergent, terminal pieces rather larger than usual. Tentacles articulated, the constrictions becoming fainter toward the base; median reaches to VIII, inner laterals to VI, outer laterals imperfect. Eyes wholly exposed, large, purplish-brown, in the usual position.

Peristomium rather short, longest laterally where it about equals prostomium, mandibular lobe not bidentate, short, oral margin very faintly furrowed and crenulate, dorsal free fold or collar short, barely reaching the median tentacle, and leaving eyes fully exposed. Second somite rather obscurely separated from prostomium, of which it is about ⅓ the length. Dorsal cirri articulated, reaching to centre of eyes anteriorly and ⅓ into somite V, posteriorly.

Somite V, the largest in the prebranchial region, is about 1½ times II. In the branchial region all somites are shorter than in the pre- or post-branchial regions. Body very little depressed, and ventral surface unusually convex, with a very faint neural groove. Anus subdorsal, with two very long more dorsal and posterior cirri equalling the 17 posterior somites, and two short more ventral and anterior ones between ⅕ and ⅙ the length of the others.

Parapodia of the usual form and modifications, but rather longer than usual, and, owing to the ventral convexity of the body, placed relatively higher on the sides. The branchiæ resemble those of *E. mucronata* in that the branches are erect upon a stem curving parallel to the body walls, but differ strikingly in that the termination of the stem, instead of bending dorsad parallel to the other filaments, as in

ɔound setæ colorless, numerous, arranged irregularly with the y setæ on an area which is nearly circular on anterior and ellip- ı posterior somites, and near the dorsal border of which the protrude; terminal thickening of shaft short, but decided, l, dorsal margin very closely and finely denticulated; appendix ort, especially on the posterior feet, where its length is scarcely han 3 times its width; tip bifid, the teeth widely separated; ʳery narrow, barely reaching beyond end of terminal tooth, its ıely denticulate.

lary setæ colorless, exposed for about 1½ times length of com- setæ, nearly straight, tapering nearly regularly from base to orsal margin minutely denticulated. Spatulate and pectinate lorless, gently widened toward end, terminated by only 7 or 8 one of the marginals being much prolonged and bent at an angle ɔlane of the others.

ıi absent from the anterior parapodia, pale yellow, 2 or 3, obliquely through the foot and protruding from the ventral its end, 1 usually considerably larger, form sigmoid, somewhat ɪ at middle, terminated by one erect tooth and a larger one, guard broad.

libles with the carriers broad and short, scarcely exceeding the te in length; the latter large, obliquely elongate ovate, widely ıt, with 3 ridges and teeth besides the prominent but rather erminal ones. Maxillæ stout, strongly hooked, with short, ınconstricted carriers. Posterior dorsal jaws triangular, toothed most the entire medial margin, the left larger, with eight coarse he right with 7 diminishing in size caudad. Two anterior aws on right, 3 on left side; the first minute with 1 tooth; the ʳongly curved, with a very broad thin plate, and 11 or 12 teeth

larger, having a length of 28 mm. for 54 anterior somites, and a maximum breadth of 2 mm. The posterior parapodia contain spermatozoa.

Prostomium of form usual in the genus, slightly longer than peristomium; ventral furrow not especially deep and lobe not widely divergent; frontal tentacles occupying entire ventral end of lobes and bounded by completely encircling furrows. Eyes 1 pair, brown, near posterior margin of head, directly below and in contact with base of inner lateral tentacles, not at all concealed by cephalic fold of peristomium. Tentacles relatively short, only very faintly articulated, the median lost in both specimens; inner lateral of seven joints and reaching to posterior end of somite VI; outer lateral of 4 or 5 joints and reaching to III. Peristomium distinct, of equal length all around and slightly less than prostomium, with which it is not fused laterally.

Second somite about ½ length of peristomium, distinct, nuchal (tentacular) cirri slender, very faintly articulated and reaching anteriorly to base of inner lateral tentacle, or posteriorly to the middle of IV. As usual the somites in the region of greatest branchial development are shorter and more crowded than either anterior or posterior to this region. The last 8 or 9 somites taper rapidly to the anal ring, which is slightly enlarged. Caudal cirri 2 pairs, the hinder very slender and delicate, equalling 11 last somites, the short one scarcely equal to the width of the anal ring.

Except for their somewhat greater prominence and the peculiarities of the neuropodial cirri, the parapodia have the characters usual in the genus. The tenth parapodium has the neuropodium roughly square in form, with the suprasetal portion more vescicular, tumid and enlarged than usual in small species, the acicular lobe between the dorsal end of the series of compound setæ, and the fascicle of capillary setæ prominent. The very characteristic neuropodial cirrus has an enlarged basin-shaped swollen base, the hollow of which looks ventrolaterad, while the terminal process is a thick, short, rounded process of its dorso-lateral margin, the whole, in certain views, having a striking resemblance to a mortar and pestle. Notopodial cirrus separated by an interval from the neuropodium, double its length, the basal half slightly swollen and receiving into its root the ends of 2 slender curved acicula, the terminal half slender and obscurely articulated.

Toward the anterior end the neuropodium is reduced in size, the depression in the base of the neuropodial cirrus is lost, and the base becomes first spherical and finally cylindrical, the notopodial cirrus approaches the neuropodium, becomes relatively longer, with a more

swollen proximal and more distinctly articulated distal portion. The extreme of these changes is exhibited by the 1st parapodium, in which both cirri are connate with the base of the neuropodium, than which the neuropodial cirrus is twice, and the notopodial cirrus 3½ times as long, the base of the former being cylindrical and twice the length of the terminal piece, while the notopodial cirrus has the proximal end much swollen, and the distal divided into 3 short joints. The second parapodium differs from the first almost solely in the larger size of the neuropodium.

With the gradual reduction in size of the neuropodial cirri toward the posterior end of the branchial region the basin-like form of the ceratophore is gradually lost, and the whole parapodium assumes the form peculiar to the posterior half of the body. The acicular lobe of the neuropodium is so reduced in size that the ends of the acicula project conspicuously beyond it. Still farther caudad the parapodia become more pointed, their outlines nearly continuous with the dorsal and ventral curvatures of the body and the two cirri of approximately equal length. The neuropodial cirri are stouter and more closely united to the neuropodium, the notopodial still retain slightly enlarged bases, but all appearance of articulation has gone.

The branchiæ are pinnate, the stem arising at right angle from the base of the notopodial cirrus and curving parallel with the back toward but not reaching the middle line; the stiff, erect branches arise at regular intervals of about twice their own diameter, are subequal in length, shorter and more slender than the cirrus, and the end of the main stem bends upward as the last pinna.

The following table shows the distribution of the branchiæ and the somites on which occur changes in the number of pinnæ on the right and left sides of both specimens:

Type. Station 3,700.			Cotype. Station 3,707.		
No. of Somite.	*Left.*	*Right.*	*No. of Somite.*	*Left.*	*Right.*
V	1	1	V	1	1
X	3	3	IX	+	3
XI	4	5	X	4	4
XIII	5	+	XI	5	6
XIV	+	6	XII	6	+
XVI	6	+	XIV	7	+
XVIII	+	5	XVII	+	7
XX	5	+	XXII	+	6
XXIII	4	4	XXV	6	+
XXVII	3	3	XXVII	3	3
XXVIII	0	2	XXVIII	0	0
XXIX	+	0			

Compound setæ occur in all parapodia; colorless, the stem curved, its end enlarged very gradually to a maximum of twice the ordinary diameter, the thickened part with oblique axial striations and a finely denticulated convex margin; appendix a relatively slender blade, the greatest width 1½ times the diameter of the stem and its length about 5½ times the width (middle of 10th parapodium), terminal teeth prominent, well separated, moderately hooked, edge of blade finely serrate, guard prolonged beyond body of blade as a sharp spine about equalling in length the width of the blade.

Capillary setæ are also found as a fascicle in the dorso-posterior part of each neuropodium; they project two or three times as far as the compound setæ, are colorless, straight or gently curved, the terminal half very finely acuminate and the surface feebly granulate. Paddle-shaped pectinate setæ appear to be absent from the first parapodium, but occur on all the others in very limited number at the base of the bundle of capillary setæ; the end is curved in half-round form, is relatively narrow, 3 to 4 times the diameter of the stem, with about twelve slender, straight points of even length and one delicate prolonged marginal process.

Both neuropodial and notopodial acicula are present in all of the parapodia; the latter are always 2 in number, very slender, tapering and with rather abruptly curved ends which terminate just opposite the apex of the angle between the notopodial cirrus and its branchia. The ordinary neuropodials are also 2 in number and enter the acicular lobe, beyond which their blunt, straight, or (posteriorly) bent ends project, most prominently posteriorly. The ʃ-shaped, hooked acicula are first detected on somite XXI. A single one (rarely 2) passes obliquely through each neuropodium, appearing at the ventro-lateral angle. They are stout, pale yellow, rather strongly curved and hooked, the principal beak-shaped process looking forward and surmounted by an unequally bifid accessory process, the smaller division of which is sometimes minute or even absent; guard wide, slightly bilobed and striate.

The color has been entirely lost except the brown spots at the bases of the notopodial setæ. The cuticle is only slightly iridescent, most so on the head.

Sagami Bay, 3,700, 63 fms., type; Suruga Bay, 3,707, 63–75 fms.

ONUPHIDÆ.

Hyalinœcia tubicola (Müller) **Mgrn.**

What should perhaps be designated as a distinct variety of this species occurs throughout the entire region of Suruga Bay and Totomi Sea, in from 63 to 167 fathoms. 3,707, 3,715, 3,737, 3,740.

Northia macrobranchiata McIntosh.

This species was dredged by the "Albatross" south of Yedo, Japan, on a bottom of green mud, in 345 fathoms. The species is evidently quite common and widely distributed throughout Sagami and Suruga Bays and the Totomi Sea in depths from 31 fathoms at station 3,703 to 749 fathoms at 3,696. A few specimens occur in the collections from each of the following additional stations, 3,704, 3,707, 3,715, and 3,740. At 3,696 a number of the peculiar tubes of this species were procured. It is surprising to find them covered at a depth of 749 fathoms with bits of wood, pine twigs and needles, leaves, straw, etc. The only entire specimen in the collection comes from station 3,704, and permits the description of the posterior end, hitherto unknown. The branchiæ continue to the 2d preanal somite, on which they still equal the foot in length, are quite thick, and bear the notopodial cirrus as a minute process, of not more than $\frac{1}{4}$ their diameter, on the external side of their base. Anal cirri 2, very delicate and slender, equalling the length of the last 7 somites.

Northia geophiliformis sp. nov. (Pl. XXV, figs. 57, 58, 59.)

Upon a cursory examination this species presents a striking general resemblance to *Geophilus* or other slender Chilopod, a similarity which is enhanced by the regular alternation of reddish-brown and pale bands across the dorsum.

The form is slender, elongated, slightly depressed and linear, but just perceptibly tapering from the anterior fourth posteriorly, the hinder body region becoming at the same time more rounded. None of the numerous specimens is complete, more or less of the caudal end being deficient in each case, but a separate caudal end of 44 somites was found. The type specimen has a length of 5.7 mm. for the anterior 109 somites and a maximum width between the tips of the anterior parapodia of 2 mm.

Prostomium small, narrow, inconspicuous, scarcely more than a common meeting place for its conspicuous appendages, and closely united with the peristomium. No trace of eyes can be detected. Frontal tentacles prominent, rather slender, fully as long as prostomium, ovate-oblong in outline, but circular in section, attached by contiguous constricted bases and strongly divergent. Palpi also prominent, about twice the size of frontal tentacles and projecting almost horizontally outward from sides of dorsum of mouth. Dorsal appendages of prostomium large and conspicuous with remarkably long annulated basal pieces, and, except the outer lateral, long, slender, whip-like styles, which are very fragile and usually detached or injured;

median tentacle distinctly smaller than inner laterals, its tip reaching only to VIII, while the inner laterals reach to XI, its base constantly only ⅔ that of inner laterals, of 6 narrow rings and terminal ⅓ not annulated, while that of the inner lateral has 9 rings and a terminal smooth portion; outer laterals in the same transverse line with inner laterals, occupying nearly the position in which eyes are ordinarily present, usually perfect, short, reaching, when reflexed, to IV only, remarkable for the great length of basal piece, which equals, or even exceeds the style, and consists of 11 annulations, decreasing in size and distinctness toward the end; style short, relatively stout, undivided, but sometimes bearing a terminal filament.

The buccal ring is probably compounded of the peristomium and the succeeding somite, the posterior bearing the tentacular cirri and the anterior the so-called palpi with which it is connected; longer than prostomium, ventral and lateral oral lobes prominent. Tentacular cirri slender and rather long, reaching to the tips of the frontal tentacles, bases with 2 or 3 obscure annuli but no distinct segments.

First 4 setigerous somites sharply distinguished from the others by their length, which causes the parapodia to stand widely apart instead of being crowded, as well as by the length and slenderness of the cirriform processes of the parapodia; first much the longest and anteriorly the widest, the succeeding three becoming successively shorter and the margins rounded, thus gradually approaching the typical form, which is short, wide and depressed, with dorsal and ventral surfaces nearly flat.

Anal segment prominent and somewhat funnelform, with 2 pairs of crowded, long, slender caudal cirri, the more posterior equal to 13, the other to 10 terminal somites.

First 4 parapodia arise at a low level from the anterior ends of their somites; except the first, which is directed slightly forward, they project almost straight laterad. Body of parapodia simple, relatively slender, and about equalling length of somite to which it is attached; bearing 3 long slender tapering cirri, the dorsal longest, the middle, which continues the neuropodium as a postsetal process, next, and the ventral shortest, the latter also attached nearest to base of parapodium ; both dorsal and ventral cirri slightly constricted at base, then a little swollen, then regularly tapering and slender. Fifth parapodium more dorsad, the base and neuropodium smaller, ventral cirrus reduced to a short, thick glandular lobe, its postsetal lobe shorter and little cirriform; it bears the first branchia. On succeeding somites the glandular area into which the ventral cirrus becomes converted

crowds the much reduced parapodium dorsad, until by XV it is directed upward and quite invisible from below, but a reverse change sets in by XXX, and, with the final disappearance of the glandular area, the parapodia again become quite lateral in the posterior half of the body. By XV also the postsetal lobe has become a small inconspicuous process, but the dorsal cirri, although somewhat reduced, remain always prominent.

Branchiæ prominent but simple, arising from a common base with the dorsal cirri, and when fully established appearing as the direct continuation of that base, of which the cirrus has more the aspect of a lateral branch; they are erect and long enough to just reach middle line of back when best developed. Sometimes they are foreshadowed by a bifurcation of the dorsal cirrus of the 4th parapodium, but normally appear abruptly on the 5th as a slender filament equalling the cirrus in length, but quickly increase to a considerably greater length, and continue with no change except a slight decrease in size as far at least as the 110th setigerous somite. As the posterior 44 somites show no trace of branchiæ it is evident that this species must reach a length quite remarkable for the genus.

With the exception of the posterior hooked acicula, which are relatively stout and pale yellow, the setæ are delicate and colorless. Compound hooked setæ are confined to the first 3 parapodia in all the specimens examined with reference to this point, and, with the exception of 2 or 3 slender pointed dorsal setæ, are the only kind present in the first parapodium; end piece with 3 processes, the terminal one longest; guard prolonged into an acute tip which reaches far beyond the body of the seta.

Slender, capillary setæ are present in all the parapodia, but in small number in the first 3, while from the 4th to about the 10th they are the only kind occurring, and are somewhat larger, with more evident serrate wings. Parapodia of the middle region each bear a tuft of such setæ projecting from the dorsum of the foot in a strongly dorsolateral direction above the hooked uncina.

Paddle-shaped setæ are first detected on the 10th parapodium, on which 1 appears, while posteriorly 4 or 5 occur between the capillary setæ and the hooked aciculum. They are very delicate and easily overlooked, with slender, somewhat curved stems and obliquely truncate, slightly curved terminal blades bearing about 16 delicate spines, and marked with as many converging striæ.

In addition to the ordinary acicula, each neuropodium, beginning at about the 10th or 12th, is provided with 2 pale yellow uncina with

longitudinally striated stem and bifid guarded tip, the promimal process being much the larger and the guard broad, closefitting and delicately striated.

Color fairly well preserved; each segment of the anterior region marked with a posterior, broader, reddish-brown band, which spreads over the entire segment laterally, and an anterior whitish or pale yellow one; head generally reddish, with a median anterior dark area; dark pigment cells also in the cephalic appendages and branchiæ; other appendages, ventral surface and entire posterior region unpigmented; cuticle with a brilliant greenish iridescense.

Tube delicate, mucoid, covered with fine silt.

North of Sendai Bay, 3,771, 62 fms. Type and numerous other specimens. Also Sagami Bay, 3,695, 175–191 fms.; 3,698, 153 fms.

PARANORTHIA gen. nov.

Intermediate between *Northia* and *Rhamphobrachium*. Two pairs of parapodia are prolonged and carried forward on the ventral side of the head as in *Rhamphobrachium*, but their setæ are coarse acicula as in *Northia*, not capillary as in *Rhamphobrachium*.

Paranorthia brevicornuta sp. nov. (Pl. XXV, figs. 52–56.)

A small species represented by an incomplete specimen of 62 somites, having a length of 22 mm. and a maximum width between the tips of parapodia of 1.25 mm.

Prostomium, as seen from above in the slightly bent up attitude of the specimen, nearly circular, but slightly and broadly emarginate behind, frontal surface smooth, regularly rounded. Eyes absent. Tentacles all in anterior half of prostomium, the paired in advance of the median, and the outer lateral well down on sides below level of frontal tentacles; basal pieces of median tentacles shorter than those of lateral, which are as long as ½ width of head; terminal pieces of median and inner lateral subequal, subulate, their length about 1¼ width of head; outer lateral shorter, equalling width of head, stouter and blunt. Frontal tentacles globoid, their constricted bases in contact on anterior margin of head. Palpi bean-shaped, length equal to style of outer lateral tentacle. Peristomium distinct, about ½ length of prostomium on the dorsum, longer ventrally, where, as well as laterally, it is crowded forward by the following somites and, with the prostomium, is bent somewhat dorsad. Tentacular cirri small, awl-shaped, about equalling peristomium in length.

The first two pairs of parapodia are enlarged and bent forward beneath the head as in *Rhamphobrachium*, but they are less produced, and the third pair is not similarly modified as in that genus. The first

reaches the level of the anterior margin of the head, and the second as far as the base of the median tentacle, the total length of the second being somewhat greater. Each is subcylindrical, about 3 times as long as thick, truncate, with short presetal and postsetal lobes, the latter somewhat longer and deeper, and a small papilla-like lobe on the ventro-distal angle. Dorsal cirri arise from the middle of the dorsal surface by a slightly constricted base and then bend outward and extend stiffly nearly parallel to the neuropodium or even approach it and reach somewhat beyond its tip. Ventral cirri also arise by a constricted pigmented base, beyond which they have the form of a spruce cone and extend toward the middle ventral line, which they nearly reach owing to the approximation of the parapodia; the first arises nearly opposite to the dorsal cirrus, the second near the base of the foot.

The third and all succeeding parapodia are lateral in position and gradually attain a higher plane; they are smaller and project straight outward. On the third the neuropodial cirrus is much shorter, broad oval in outline, and on succeeding parapodia becomes a mere opaque rounded lobe, which gradually becomes less and less prominent and disappears at about XXX.

The tenth foot is typical. It consists of a short truncate neuropodium with a small presetal lobe, a tapering bent notopodial cirrus of about twice its length, and the reduced neuropodial cirrus. The posterior parapodia are further reduced, but, owing to the very poor preservation of this region, cannot be accurately described.

Branchiæ appear on somite X as a single thick filament rising from the dorsal side of the notopodial cirrus; the branchia is double the length of the cirrus in succeeding somites, becoming bifid on XXIII and thence backward rising erect as two equal divisions twice as long as the cirrus. The posterior end is much macerated, but on the last 12 or 15 somites the branchiæ appear to consist of single filaments of undiminished length.

On a very large number of parapodia the setæ are destroyed, but enough remain to permit the description of their general character and distribution. The first two enlarged parapodia each bear 3 large setæ or acicula, but unfortunately the tips of all have been broken off. Succeeding somites exhibit compound, capillary and paddle-shaped setæ, all of which are colorless.

Compound setæ of two forms, the first of which appears to be confined to a group of about half-a-dozen in the ventral part of the third parapodium; they have the end of the shaft rather abruptly enlarged

on both sides for a short distance, margin of socket tipped by a rather long process, proximad to which are a few rather conspicuous teeth; blade relatively short and broad, strongly hooked and bifid at the end with a guard somewhat produced at the apex. In addition to these all of the anterior parapodia, from the third at least to the fifteenth, bear in the middle and ventral part of the neuropodium a number of compound setæ without guards; these are more numerous anteriorly than posteriorly; the shafts have nearly the same form as the guarded setæ, but the blades are straight or only slightly curved, rather broad proximally, but with slender mucronate tips and obliquely striated with one or both margins finely serrate; the blades vary greatly in length, those in the dorsal part of a bundle being more than twice as long as the most ventral ones in the anterior parapodia, while posteriorly only the short ones remain. No compound setæ occur in the most posterior region, but just where they cease cannot be accurately determined.

Capillary setæ are the most numerous and constant, occurring in all parapodia from the third caudad. They differ considerably in length, those dorsad of the aciculum being the longest and the stoutest as well, those ventrad, which replace the compound setæ as they disappear, retain about the length of the latter. Toward the extreme posterior end they appear to diminish both in number and size. All are slender, tapering, very acutely pointed with a narrow smooth-edged wing, at the beginning of which a more or less pronounced bend occurs.

Paddle-shaped setæ are also found in the extreme dorsal part of some of the anterior somites, but their distribution has not been ascertained. They have very slender shafts, wide, suddenly expanded, asymmetrical, curved ends provided with about 20 very fine points of equal length.

All of the acicula are very pale yellow. Besides the projecting acicula or setæ, the first two parapodia exhibit several (perhaps about 10, though the number cannot be certainly determined) long thread-like internal acicula of constant thickness arranged parallel to one another in a regular coil within the foot, those of the first being especially long and forming an additional snarl near the base of its ventral side. Notopodial acicula also appear, those of the first 2 feet being rather strong, straight and stiff and ending in the base of the cirri; in the remaining parapodia they are delicate fibres passing far into the cirri. The ordinary neuropodial acicula are 3 in number, the dorsalmost very stout, all straight and tapering, with the slightly protruding point blunt or slightly enlarged and sometimes a little curved. Guarded aci-

la have been detected in the ventral part of the neuropodium as far rward as the eleventh foot. Usually two occur, and they are slender, ›t exceeding the larger compound setæ in diameter, nearly straight, ghtly enlarged below the tip, which is bifid and provided with a oad guard.

Suruga Bay, 3,713, 45 fms.

uphus cirrobranchiata sp. nov. (Pl. XXV, figs. 60–63.)

A rather small species, the type of which consists of 59 setigerous mites, and measures 42 mm. long, with a width of body at somite X 2.3 mm., and a maximum distance between the tips of the parapodia the same place of 5.2 mm.

Prostomium small, about semicircular from above, the length about ļuàlling the peristomium at the sides. Eyes, 1 pair, reddish-brown, rcular, entirely exposed; frontal tentacles prominent, rounded, ngth ½ length of prostomium, strongly divergent, directed forward, ›wnward and outward. Tentacles with short articulated bases, which ·e little longer than thick and about equal frontal tentacles in size, ıch of 2–4 rings; styles slightly enlarged at base, long, slender, nooth, entirely non-articulate; median longest, reaching somite IV, inner lateral XI, and outer lateral IV. Palpi short, thick, promi-ɜnt, slightly bilobed, strongly divergent from ventral surface of head, ıd connected with ventral margins of lateral peristomial lobes by a air of ridges.

Peristomium (which probably consists of two coalesced somites, the rst very small and anterior to peristomial cirri) longest laterally, there ļualling the prostomium; cirri directly in line with eyes and far for-ard, slender, tapering, short, scarcely reaching anterior boundary : prostomium, and posteriorly to middle of somite III.

Somite III (next to the peristomium) is nearly equal in length to ıe prostomium and peristomium combined or to somites IV and V, ıterior margin much wider than posterior and projecting considerably eyond any other anterior somite. Remaining somites well defined, ıd of about equal size until the tapering posterior region is reached. ody rounded, very little depressed, most so in the middle region when istended with eggs, dorsum high and arched, venter flattened. Anus ɜrminal, the anal somite truncate and slightly crenulate; caudal cirri ɜry long and slender, equalling the last 16 or 17 somites.

Enlarged first pair of parapodia very prominent, nearly equalling ıeir somite in length, and projecting strongly forward by the sides of ıe head, and slightly outward and downward; form simple, postsetal be elongated, reaching slightly beyond tip of slender dorsal cirrus

which arises from middle of foot, ventral cirrus shorter, arising from base of foot and ending opposite root of dorsal cirrus.

All other parapodia are much smaller, but the 2d and 3d project slightly forward, and are somewhat transitional in other respects also; dorsal cirri and postsetal lobes increase in length and become slender and tapering, reaching their maximum by XI or XII, when the latter is fully equal to the body of the foot, and the former is 3 times as long and capable of reaching the dorsal mid-line, though habitually carried outward and backward; beyond this region they decrease in length, the postsetal lobe retaining its slender form, but becoming of insignificant size by the middle of the body, while the dorsal cirrus reaches as far as the tips of the setæ. The ventral cirrus diminishes in size rapidly; on the 2d and 3d it remains as a short thick cirrus, by the 4th it is a low dome-shaped opaque whitish lobe below, and distinctly separated from, the foot; posterior to XII it diminishes, and has practically disappeared by XVIII.

The branchiæ are characteristic. They usually begin as a single filament, or occasionally two, on XIII or XIV, arising with the dorsal cirrus from a common base, and dorsad of the latter; this quickly becomes subdivided quite to the base, which shifts its position to the caudal side of the cirrus. The division into 2, 3 and 4 filaments takes place somewhat irregularly, but each filament attains practically its full length immediately; by XVIII or XX the typical number of 5 is reached, and continues, with occasional variations to 6, to about XXXV, when 4 again becomes the predominant number to about XLVIII, beyond which it further diminishes; somites LVI to LVIII bear only small but distinct branchial tubercles, and LIX, the last segment bearing parapodia, has none. Some variation in the number of filaments occurring on somites toward the ends of the series is noticeable. The filaments of which the branchiæ are composed are very delicate and, as their wrinkled condition indicates, very contractile; they are generally about $\frac{2}{3}$ as long as the dorsal cirri, but probably equal or exceed these in life, are deeply cleft and arise in a cluster, though occasionally a more pectinate arrangement is indicated.

Setæ of four kinds, two being coarse uncini. Compound uncini confined to the first 4 parapodia, yellow, stout; appendix curved, bifid, the terminal process large and hooked, the accessory one much smaller, both included in the delicate double truncated guard. This is the only form of seta in the first foot, in which some of them become very large and, in one example, lose the articulation, though this is present in the type specimen; they become successively smaller on the 2d, 3d

and 4th parapodia, in which they lie just ventrad of the other setæ and next to the postsetal lobe.

Beginning with the 5th parapodium, simple uncini replace the compound ones just described, though they are only fully established several somites further caudad, and are usually two in number throughout the anterior branchial region, but may be 3, or even 4, toward the posterior end. They are yellow, stout, nearly straight or slightly bent back (this direction being opposite to the compound uncini), slightly swollen subterminally, the end bifid with two stout, ventrally directed processes, of which the proximal is the larger; guard obliquely fan-shaped and striated; stem rather coarsely striated, which is not the case with the compound uncini.

Slender, pointed setæ occur in all of the parapodia except the first, arranged in typical somites in two horizontal rows above and below the uncini, the dorsal one being larger. These are the only setæ of sufficient length to reach beyond the postsetal lobe, and anteriorly even these do not. Stems much slenderer than the uncini, only the larger ones exhibiting any color, bent dorsad abruptly but slightly at about the middle of the exposed portion; a reverse but more gentle bend in the opposite direction, bringing the terminal part into a direction parallel to the base, occurs in the setæ of the posterior half of the body; flange always on ventral side, widest at angle of seta, disappearing terminally, leaving an acute very brittle point; both stem and flange obliquely striated. On the 4th parapodium the flanged setæ are smaller and fewer; on the 3d and 2d only the dorsal bundle occurs, reduced on the latter to 2 or 3 very small, acute, scarcely winged, colorless setæ. Posteriorly also the winged portion becomes reduced in length.

The 4th kind of seta is the most numerously represented but the least conspicuous of any; a single one appears in the dorsal bundle of the 2d parapodium, but in all succeeding parapodia a close bundle of many occurs between the postsetal process and the dorsal fascicle of flanged setæ. They are of very unequal length, the longest being on the posterior side, but none equal ½ the length of the flanged setæ. They have slender stems terminated by a delicate funnel-shaped enlargement with a crenulated or toothed margin.

Sagami Bay, 3,698, 153 fms.; 3,704, 94 fms.; 3,707, 63–75 fms.; Suruga Bay, 3,738, 167 fms., type.

LUMBRICONEREIDÆ.

Lumbriconereis heteropoda v. Marenz.

This species and *L. bifurcata* McIntosh are very closely allied, if not identical; some of the examples contained in the present collection are so nearly intermediate between the two that difficulty was found in referring them. As a whole the series is most closely connected with *L. heteropoda*, which is also the prior name. It is the most abundant and widely distributed species contained in the collections, occurring at all localities on the coast of Japan at which dredging was done, though in many cases represented by fragments only, and at depths from 36 to 190 fathoms. It was taken at the following stations: 3,695, 3,698, 3,703, 3,707, 3,714, 3,724, 3,735, 3,738, 3,739, 3,740 and 3,755.

Lumbriconereis japonica v. Marenz.

Sagami Bay, 3,698, 153 fms.; Suruga Bay, 3,717, 100 fms.; 3,718, 65 fms.; 3,736, 480 fms.

Laranda robusta sp. nov. (Pl. XXVI, figs. 64, 65.)

This is evidently a species of large size. The incomplete type specimen has a width of 6.5 mm., and a length of 165 mm. for the head and anterior 202 somites, and a smaller example of less than ½ the diameter of the type, consisting of upward of 400 somites, of which the posterior 100 or so have been recently regenerated, measures 210 mm.

The prostomium has a peculiar flattened form, curved and hollowed below like the bowl of a spoon; the outline from above has the form of a haycock with a broad base; in the larger specimens its length is less than the first 3 somites, in the smaller one considerably greater; in both it has a distinct dorsal longitudinal sulcus, and is slightly dovetailed into the peristomium. No eyes visible.

The peristomium and the next segment are nearly identical in form, the former differing only in its relation to the mouth and prostomium, and in the more strongly marked postoral grooves; both are very distinctly marked, and are shorter than the first setigerous somite.

The body is nearly circular in section throughout, the dorsum slightly more convex than the venter, with the parapodia somewhat below the middle lateral line, especially toward the posterior end. The diameter is remarkably uniform, with a slight increase toward the middle, and a sudden diminution in the last 7 or 8 mm. of the small specimen. All of the segments are very distinctly marked and of equal length for at least ⅚ of the length. No anal cirri are present.

The parapodia are uniform in character throughout; in the middle of the body, where they reach the largest size they about equal the

ɔstsetal process and the presetal welt. In the anterior parapodia ɜlender setæ occur, and are arranged in two somewhat divergent ɪs, of which the ventral includes 4 or 5, the dorsal 8–12. All are ɔrown, long, slender, simple, sharp-pointed and wingless, with a ɜ sigmoid curve. After about the first 20 somites the setæ of the l bundle become stouter and of a deeper color. More posteriorly, ɜ type at XXVI on one side, XXVII on the other, a single stout lum appears with its end projecting at the ventral end of the . It has much the form of a blunt pointed lead pencil and is leep brown color.

ɜ color is an iridescent purplish-brown with dark brown spots ɜ the bases of the parapodia, which tend to spread toward the ın line as incomplete narrow zones on each somite.

ɔe, Suruga Bay, 3,709, 173 to 260 fms.; also Suruga Bay, 3,737, , 3,739, 65 to 167 fms.

rrus sonata sp. nov. (Pl. XXVI, figs. 66, 67.)

ɔiece of the posterior end consisting of upward of 120 somites, ɜpresenting probably nearly ½ of the animal. It measures 65 mm. ınd 3 mm. wide including the parapodia, but not the setæ. The is nearly circular and tapers toward the anus, which is guarded ɔair of short broad lateral lobes representing a pair of cirri or per- two pairs coalesced.

ɜ parapodia are described from the most anterior somite present; ıre situated about twice as far from the dorsal as from the ventral e line, are rather small and slender, with a prominent posterior al process, which is somewhat longer than the rest of the foot, and ɜcted caudad and laterad. Dorsal papilla small but prominent. æ 5, 2 in dorsal, 3 in ventral bundle, colorless or nearly so, with deli- tapering and winged tips, and sigmoid with the ends directed dor- those of the ventral bundle shorter and only slightly bent; of

Ninoë palmata sp. nov. (Pl. XXVI, figs. 68–71.)

Represented by 98 anterior somites, having a length of 34 mm. and a width of 2.5 mm. at somite XX.

Prostomium of the form of a depressed convex cone with a rather acute apex, length 1½ times the base and about thrice length of peristomium, dovetailed ⅓ into peristomium on dorsal side, delicate lateral grooves from palpi to apex. No eyes visible. Palpi large, free lobes at sides of mouth and dorsad of it. Peristomium longest at sides of head, to which and to the succeeding somite it is partly united laterally; ventrally produced into 3 lobes bounding the mouth laterally and posteriorly.

Somite II distinct, except where united with the peristomium ventrolaterally, length about ⅔ peristomium; it bears no parapodium. Succeeding somites very distinct, outlines rounded and regular and of nearly equal length throughout. Body exactly circular, although the presence of the branchiæ give to it a somewhat depressed aspect.

Parapodia appear on II, short, about equal to length of somites from which they arise, the branchiate ones somewhat exceeding this, prominent, sloping slightly forward, outline nearly straight to the broadly rounded or truncate end, which is divided into presetal and postsetal lobes, the former somewhat the longer, the latter bearing the gills.

The branchiæ are processes of the postsetal lobe, which even as far forward as V has developed a longer cirrus-like dorsal piece and a shorter and thicker ventral piece. On succeeding somites the former diverges more and more dorsad, and from the dorsal side of the ventral division successive short thick filaments arise, there being 2 branches on V, 3 on VII, 4 on IX, which number continues, with occasional variations to 5, to XXVI or XXVII. When best developed the branchial filaments spread ventrad well below the setæ; the dorsalmost cirrus-like one is about twice the length of the others and curves over the back; the next one or two are separated but the lowermost 2 or 3 remain connected and diverge like fingers in a palmate manner. All are much wrinkled and evidently contractile. The dorsalmost filament disappears suddenly at about XXX, and the others gradually undergo reduction until finally only a minute papilla on the postsetal lobe remains.

Setæ of two types, both simple; bent lance-shaped ones and hooked, guarded ones which exhibit two modifications toward the two ends of the body. The lance-shaped setæ are pale yellow, colorless at the tip, and occur in two groups in anterior somites, the number being reduced more posteriorly by the gradual replacement of the middle ones by

hooked setæ; they are most numerous in the dorsal group (5–6 dorsal and 2–3 ventral in the middle branchial region) and here persist the longest; the knife-edge flange delicately striated, widest at base, diminishing toward tip, and leaving a very acute point, flange directed dorsally in the ventral setæ, ventral in the dorsal; shaft of setæ bent more or less strongly at the base of the flange and on the margins of the bundle, the tips often recurved in the opposite direction. Posteriorly the lance setæ become reduced to 2 or 3 in the dorsal bundle; darker, even black, in color, straighter, more slender and with a much reduced flange.

The hooked setæ of the anterior segments exhibit transitional characters between the lance-shaped setæ and the posterior hooked ones. Anteriorly they are pale yellow, posteriorly darker as they pass into the more typical hooks, stouter than adjacent lance-shaped setæ, but of the same form until near the tip, when the shaft suddenly contracts, bends slightly backward and terminates in a short truncate hook, bearing about five short teeth of diminishing size; at the same place the flange forms a guard which includes the hook and conforms to its shape. Posteriorly the hooks become darker, longer, the tip stouter and more prominently hooked, the number of teeth 7 or 8, of which the most proximal is the largest, the blade absent except where it forms the hood-like guard, and the stem club-shaped.

Skin strongly iridescent, but color all gone.

Only the type known from station 3,767, Sendai Bay, 14–18 fms.

GONIADIDÆ.

Goniada (Leonnatus) foliacea sp. nov. (Pl. XXVI, figs. 75, 76.)

The largest specimen measures 98 mm. long, 4 mm. between the tips of the setæ in the anterior region, and 5.3 mm. at the beginning of the posterior region. The relatively stout body consists of 160 somites, in addition to perhaps 3 or 4 which have been lost at the caudal end. The posterior region, beginning at somite LXIII, is filled with sexual products in the larger individuals and, being very readily detached, may separate and swim independently at maturity.

Head prominent but shorter than in most species, bluntly conical, slightly depressed, length twice width, composed of only four strongly marked rings, the basal one nearly equalling all the others in length, and the latter decreasing to the tip, furrows on ventral and dorsal surfaces alternating in position and joined by a pair of lateral zigzag grooves which terminate caudally in a small slit-like pit on each side of the peristomium, dorsal to the palpi. On the ventral surface of the

head is an elongated, narrow, triangular, depressed, translucent area reaching from the apex to the mouth, into which the annular grooves do not extend, thus cutting off on each side lateral portions of the rings, which appear as four pairs of low, thick, slightly projecting lobes to which the depressed form of the head is chiefly due. The 4 apical tentacles are present in but one example, and even in this are imperfect through maceration. Palpi (lateral lips), a pair of prominent rounded lobes, with largely free, thin, anterior margins at the sides of the mouth. Peristomium indistinctly separated from the base of the prostomium and the first foot-bearing somite; ventrally it forms a prominent median lip. In two of the small examples from Sta. 3,771 and one larger from Sta. 3,695, a minute cirrus is present just in line with the parapodia on the buccal ring, but cannot be detected in the type specimen, which is the largest examined. It is possible that the buccal ring may consist of two somites in this genus.

Except the first, all foot-bearing somites are distinct, and in the anterior region about 3 to 3½ times as wide as long, increasing in size to about XLV, then remaining without material change to LXIII, between which and LXII a weakening of the body walls occurs, caudad of which the width rapidly decreases for 4 or 5 somites, beyond which the body assumes a linear form, though the much increased length of the parapodia results in a greater total width and a more depressed aspect than anteriorly. About 100 somites constitute the posterior region; the type has 97, but 3 or 4 caudal somites are wanting. Some smaller specimens with the anal ring present lack caudal cirri, which have doubtless been lost.

As typical of the anterior region the parapodium of somite XV may be described. This consists of a rather stout neuropodium having a length equal to ½ the width of the somite, and divided into a broad, foliaceous, ovate pyriform presetal lobe, the tip of which is divided by a deep cleft into two narrow tongue-like halves, and a somewhat slender lanceolate postsetal lobe, placed just opposite to the cleft in the presetal lobe, which it slightly exceeds in length. Ventral cirrus arises from basal half of neuropodium, rather thick and stout; its tip falls a little short of the setigerous lobes. Dorsal cirrus consists of a rather stout rounded stalk, with swollen base and somewhat flattened, foliaceous, nearly orbicular or broadly ovate-lanceolate appendage, which bends abruptly dorsad.

Toward the head the postsetal lobe becomes shorter than the presetal, and is absent in the first 3 parapodia; the presetal also becomes narrower, and finally loses the terminal bifurcation; the cirri approach

more closely and crowd the neuropodium, the foliaceous character of the dorsal cirrus disappearing. The first parapodium consists of a neuropodium without setæ, but bearing a long, slender, cirrus-like presetal lobe, and dorsal and ventral cirri, which differ from the typical ones only in their smaller size. Posteriorly, beginning at about somite XXXV, a small conical notopodium appears just ventrad and cephalad of the dorsal cirrus. This bears setæ at once, and, in relation thereto, is divided into narrow presetal and postsetal lobes, of which the latter is more ventrad, features which become more evident as the notopodium increases in size toward the end of the anterior region.

The first few parapodia of the posterior region are transitional in form, but quickly become more foliaceous and assume the characteristic structure which is typically developed on somite LXXV. Here neuropodium and notopodium are well separated by a wide interval, and each bears its appropriate cirrus. The former is essentially as in the anterior parapodia, but both lobes are much broader and more leaf-like, the 2 divisions of the presetal more divergent, the dorsal considerably the larger and both longer than the postsetal lobe; ventral cirrus relatively shorter. Notopodium about one-half length of neuropodium, obtusely rounded, broadly attached, and not constricted at base; presetal and postsetal lobes not prominent, the latter more ventral, so that an oblique terminal notch appears in face views of the parapodium. Dorsal cirrus rises from the base of the notopodium, and is directed almost vertically dorsad; form similar to anterior cirri, but stalk shorter. More anteriorly each lobe of the notopodium bears a slender terminal papilla, that of the presetal being quite long and slender. Toward the posterior end the two divisions of the foot become still more widely separated, and both again more slender and less foliaceous, while the dorsal presetal lobe of the neuropodium becomes more prominent.

The neuropodial setæ are arranged in a single vertical fan-shaped row, which spreads very widely in the foliaceous swimming feet of the posterior or genital region, the number of setæ corresponding closely with the width of the lobe. All are of the same form, compound, with very long stems, especially on the swimming feet, and slender, finely pointed, and very delicately fringed blades, which are longest in the middle of each bundle and diminish dorsally and ventrally. The figure does not show the full side view of the blade.

Notopodial setæ similarly arranged in a fan-shaped vertical series of correspondingly smaller spread; all simple, colorless, slightly bent and curved, and tapering to an extremely acute point; the surface marked

with fine granules arranged in oblique rows and appearing as somewhat irregular serrations at the edge.

Jaws black or deep brown and opaque, forming a continuous but irregular ring just caudad of a circle of 18 obtuse lobes which lie at extreme the end of the fully protruded proboscis, and when retracted cover the jaws in somite XXIII. One principal jaw on each side and dorsad, the left one bearing two long hooked spines shaped like the venom fangs of serpents; the right one bearing in addition 2 or 3 smaller but similar spines on the medial side. In the dorsal interval between the principal jaws are 14 or 15 smaller accessory ones arranged in an irregular transverse band; they are of inconstant form but each bears a pair of, or even 3, hooked teeth on a rather stout base. The ventral distance between the principal jaws is more than twice the dorsal, and is occupied by a fairly even and continuous row of 28 to 30 small jaws of various sizes and forms, some being quite rudimentary. As a rule each bears a single claw-like hook directed, as are the others, caudad on an irregular orbicular base having a pair of anteriorly directed, divergent processes. No longitudinal series of accessory jaws is present.

A low muscular fold runs along the mid-dorsal line of the pharynx from its cephalic attachment to the predental lobes, but does not involve a complete folding of the pharyngeal walls as in *Goniada distorta*. The proboscis papillæ are all of one kind, elevated mammiliform, the enlarged somewhat pyramidal bases much crowded in the retracted organ and the teat-like summits pointed and slightly curved. They measure .014 mm. in height, and .009 mm. in diameter of base.

Color a general gambose yellow, lighter in the furrows and on the contiguous surfaces of parapodia and in the head region, and modified posteriorly by the presence of the eggs, which crowd the sides of the somites and the parapodia. The anterior region, exclusive of the head and a few somites, is very dark and opaque from the presence of an abundant purplish-brown pigment deposited in a narrow zone around each somite, which broadens above and below each parapodium, and affects the terminal parts of the cirri and, to a less degree, the setigerous lobes. The anterior end is iridescent with greenish and bluish reflections. A curiously constant feature is a ventral series of minute but conspicuous black spots, situated in the median line of each intersegmental furrow of the posterior region, at the beginning of which they appear abruptly.

Sagami Bay, 3,695, 190 fms., type and one other specimen; North of Sendai Bay, 3,771, 62 fms., 4 specimens of smaller size.

Goniada distorta sp. nov.

This species is described from a single incomplete specimen consisting of 106 somites and having a length of 66 mm., and in the anterior region a width of body of 2 mm. and between the tips of the parapodia 2.8 mm., while posteriorly the same measurements are respectively 1.3 mm. and 3.7 mm.

Body slender and nearly round throughout, increasing in diameter to somite LX, then diminishing and becoming linear posteriorly; rather wider dorsally than ventrally and somewhat tumid above the bases of the parapodia; posteriorly the great length of the parapodia gives an appearance of depression.

Head of the usual tapering, elongated form, consisting, besides the basal piece, which constitutes nearly $\frac{1}{3}$ of its length, of 7 distinct annulations, diminishing in size and terminated by an 8th slightly wider one. The prostomium is circular, not flattened as in *G. foliacea*, and the furrows are continuous all around; there is no lateral groove, but a pit is present on each side at the posterior margin of the head. Only a single imperfect apical tentacle, of clavate form and having a length about equal to the apical ring, is present. Eyes absent. Peristomium not clearly distinguished from the succeeding somites. The partial protrusion of the pharynx greatly alters the appearance of the mouth, but the lateral lobes or palpi, and the lips appear not to differ from *G. foliacea*. The somites are distinct, but show no indication of subdivision into rings.

The parapodia differ in many respects from those of *G. foliacea*. The anterior or uniramal ones are prominent and slender, have a length exceeding $\frac{1}{2}$ the diameter of the body, and stand out abruptly from the middle of their somites. Neuropodium a compressed cylinder about as deep as long, bearing at the end one postsetal and two presetal cylindrical cirriform processes, of which the dorsal presetal is slightly the longest. Neuropodial cirrus, which also arises near the end, but on the ventral posterior face of the neuropodium is slightly longer, and at its base nearly twice the diameter of the setal lobes, and has a conical form. Notopodial cirrus separated by a narrow interval from the neuropodium; it is swollen basally and, near the middle of its dorsal surface, is provided with a shallow depression lined with tall columnar cells, beyond which it bends abruptly dorsad at an angle as though deformed, and terminates as a blunt cylindrical or conical piece not at all foliaceous.

The typical foot of the anterior region just described is retained with little change as far forward as the 4th. The 3d parapodium has

only a trace of the dorsal presetal lobe, and the cirri are of larger size than in the typical foot. The 2d bears still larger cirri, united with the neuropodium, and the latter is still further reduced. The first postbuccal somite bears a fully formed trilobate setigerous parapodium like the second on the left side, and only a simple cirrus on the right side.

Toward the posterior end of the anterior region the base of the neuropodium increases, and the terminal lobes, especially the presetal, diminish in length. The neuropodial cirrus at the same time increases until its tip reaches beyond any other part of the foot, while the ventral portion of the neuropodium which bears it becomes partly cut off by distinct anterior and posterior furrows. Meanwhile the notopodial cirrus has become relatively shorter and stouter and its terminal part slightly flattened antero-posteriorly. All of these changes become progressively emphasized. Not till the 54th somite does the notopodium appear as a slender process arising in common with the notopodial cirrus, and reaching as far as the tip of the postsetal lobe, but not to the end of the neuropodial cirrus. After its abrupt appearance the notopodium becomes gradually shorter and more and more closely united with the cirrus. Although from its beginning supported by an aciculum the notopodium at first bears no setæ, and even as far back as the 65th foot only a single one has been detected. Indeed, throughout the entire region notopodial setæ are very few.

No further important change occurs until somite LXXVI, when the body rather rapidly decreases in diameter and assumes the linear character of the posterior region, while the parapodia increase in length to 1½ times the width of the body, a change due in part to the larger size of the neuropodium and notopodium, but still more to their elevation upon a common base. Taking the 100th parapodium as a typical example the following description applies: Base of parapodium nearly as deep as body, swollen with spermatozoa in the example studied, as long or slightly longer than neuropodium, which is again longer as well as deeper than notopodium, each of which divisions is supported by a single rather stout, straight, tapering, yellow aciculum. Neuropodium divided into two rather short (the dorsalmost the longer), pointed, presetal lobes, and a much broader, leaf-like, postsetal lobe, the somewhat shorter tip of which lies opposite the interval between the slightly divergent presetal lobes. Neuropodial cirrus elongated conical, arising from a distinct base about the middle of the ventral surface of the body of the neuropodium, its tip reaching to end of ventral presetal lobe, from which, however, it naturally diverges ventrad.

odium united with its cirrus for about ¾ of its length, only their ree as short, pointed, triangular, nearly symmetrical, divergent postsetal lobe rudimentary; cirrus still retains sensory depres- ut of much reduced size.

setæ are of two kinds. Those of the neuropodia are arranged ingle fan-shaped group, larger in posterior than anterior somites, lways very much inferior in size to those of *G. foliacea;** all are ss, compound, with very slender tapering delicately fringed ter- pieces, which are 3 or 4 times as long in posterior as in anterior s. Notopodial setæ are few in number; when most numerous posterior region forming a small fan-shaped fascicle; simple, ss, shorter but stouter than neuropodials, slender, slightly l, very finely pointed, and with the rather coarse granulations ed to the convex border.

rynx very long, the jaws in its retracted state in somite XLII; ngitudinal muscular fold larger than in *G. foliacea*, with a corre- ing groove on the cœlomic face of the pharynx, and reaching e entire length of the proboscis; owing to a half turn of the pha- ts posterior end passes spirally around to the ventral side, with the jaws. Papillæ of two forms; very numerous bluntly conical ones ring only .003 mm. in height are arranged in close irregularly e rows over the greater part of the surface; somewhat larger ones ompressed bifid summits occur more sparingly and are confined muscular ridge. Both have the cuticle thickened and have a sensory pore just behind the apex. Predental lobes 16 or 18, ishing slightly in size from the dorsal to the ventral side. Jaws opaque, forming a complete ring; larger ones somewhat dorsad, etrical, each with four claw-like teeth, diminishing in size dorso- d. Accessory jaws in a nearly regular ring, but the alternate owing to somewhat smaller size, stand a little anterior to the ; with the exception of a very few unifid and trifid ones, all are and of similar form, with the two teeth nearly equal and some- divergent, the bases irregularly rounded or with a pair of rather forwardly directed processes; 13 occur between the dorsal inter- and 18 or 19 ventrally, the latter distance being about twice the r, and the jaws consequently less crowded.

color is pale yellow, the cirri and other terminal parts of the pos- parapodia with some brownish-yellow pigment; anterior part ly very pale with a pinkish iridescence.

oteworthy feature is the occurrence in this species, as in *G. foli-* of ventral, intersegmental dark spots on the posterior region.

They begin abruptly at somite LXXVII but are less distinct than in that species.

Suruga Bay, 3,739, 35–65 fms.

GLYCERIDÆ.

Glycera gœsi Mgrn.

I am quite unable to distinguish between this species and *G. decipiens* v. Marenz., under which latter name it has already been recorded in Japanese waters from the Bay of Miya. The examples from the "Albatross" dredgings are all of small size. In some the gills are very regularly developed, in others most irregularly and in still others they are altogether retracted. They come chiefly from moderate depths at the more northern stations.

Suruga Bay, 3,715, 65 fms.; 3,723, 13–16 fms.; Sendai Bay and north ward, 3,767, 14–18 fms.; 3,768, 25–27 fms.; 3,771, 61 fms.; 3,775, 57 fms.

Glycera tesselata Grube.

This species is widely distributed in the Atlantic Ocean, but has not been hitherto recorded from Pacific waters.

Sagami Bay, 3,698, 153 fms.

Glycera alba Oersted.

Like *G. gœsi* this species is represented, with one exception, by small examples only and the gills are frequently minute vesicles. The tubercle which appears on the parapodium just above the branchia in Malmgren's, but not in Oersted's, figures is absent in all of these specimens.

Sagami Bay, 3,702, 31–41 fms.; Suruga Bay, 3,707, 63 75 fms.; Suruga Bay, 3,740, 65 fms.; North Japan, 3,767, 14–18 fms.; 3,775, 57 fms., the latter the only large example taken.

Glycera robusta Ehlers.

The anterior end of the single large example by which this species is represented is interesting from the regular occurrence of small colonies of dichotomously branching ciliates between the parapodia. These bear a most striking resembling to the "gills" of *G. opisthobranchi* v. Marenz.

Suruga Bay, 3,718, 65 fms.

ARICIIDÆ.

Aricia fimbriata sp. nov. (Pl. XXIV, figs. 31–35.)

A specimen comprising the head and 83 setigerous somites, with a length of 60 mm. and a maximum diameter of 7 mm., is the type of

this species. Form as usual in the genus, depressed, flat dorsally, strongly convex ventrally, stout anteriorly, and tapering into a long slender fragile posterior region. This is evidently a species of considerable size, but is represented by 3 short anterior ends and a fragment of the posterior end.

Head mammiform, as viewed from above, with a dome-shaped basal piece incomplete ventrally, being cut into by a low median ridge which is continued to the mouth from the regularly conical pointed terminal piece. Mouth ventral, a rather small slit-like or slightly quadrate opening, bounded posteriorly by the 2d setigerous somite, laterally by the lobe-like thickenings of the 1st setigerous somite, and anteriorly by the caudal end of the prostomial ridge; its four angles are prolonged into chinks passing into the furrows bounding the 1st setigerous somite, which is incomplete ventrally, and between the oral lobes of which the second setigerous somite is produced as a wedge-shaped hinder lip.

Parapodia biramous throughout, the first 16 relatively low, with very broad attachment on lateral faces of somites; both notopodia and neuropodia with broad, more or less pectinate postsetal lobes, the latter much the better developed; posterior to the 18th the parapodia are entirely dorsal, the fimbriated postsetal lobes are replaced by simple ones, and the neuropodium is rudimentary. The 10th parapodium, which is typical of the anterior region, exhibits the following characters: The two rami separated by a narrow cleft; the neuropodium more than twice as broad as the notopodium, strictly lateral, consisting of an extensive, sessile, setæ-bearing area about 4 times as long transversely as longitudinally, an obscure presetal lobe, and a postsetal lobe which is provided at a short interval from the setæ with a high fold bearing about 12–14 conical marginal processes, the dorsalmost of which are somewhat enlarged; notopodium generally similar, the setigerous area raised as a very low compressed ridge, the postsetal lobe narrower but higher, in correspondence with the longer setæ, obliquely and broadly palmate, somewhat like a moose's antlers, and bearing about 8 marginal processes which trend dorsally, toward which side they are larger and the last sometimes bifid. Anteriorly the changes in the parapodia consist in a gradual reduction in size of the entire foot, with a diminution of the neuropodial setigerous areas in vertical extent, and a decrease in number of the postsetal processes, until the neuropodium bears but 3 or 4, and the notopodium usually a larger bifid one. Posteriorly the neuropodial setigerous area suffers in extent by a reduction from the posterior and dorsal borders, the postsetal lobe gradually

shrinks from the ventral margin, from which a few of its papillæ become detached and appear quite isolated on the body walls of the posterior somites of this region and the following transitional region; but such papillæ are few and small, and appear only on the lateral portions of somites XVI to XXI or some of these; the dorsal margin of the notopodial postsetal lobe, with its papillæ, elongates until it appears as a main stem bearing the remaining papillæ on its lateral side.

The 17th and 18th parapodia are transitional but resemble those of the posterior region more closely; they are, however, less dorsal and usually exhibit a few papillæ just ventrad of the parapodia. The 19th is quite typical of the posterior region, directed dorsad from the upper part of the sides of the somite, neuropodium narrow but prominent and erect, with a small leaf-like ovate presetal process having a strong basal constriction, a small conical recurved postsetal process, and, below the constriction, a minute conical neuropodial cirrus, apparently derived from the dorsalmost postsetal papilla; notopodium broader and much more conspicuous, consisting of a setigerous tubercle and a greatly enlarged, pointed, ovate-lanceolate, postsetal process nearly equalling the gill in length, with a constricted somewhat flattened base, and an asymmetrical wing to the blade-like extension of its lateral margin. Changes in the parapodia toward the posterior end consist in slight alterations in proportion of parts; the entire foot becomes more elongated and narrow, the notopodial postsetal lobe even larger and more leaf-like, assuming the form of the branchiæ, except that its base is always constricted, and the neuropodium more reduced in size.

Branchiæ of nearly full size begin abruptly on the 5th setigerous somite and continue as far as the material reaches toward the posterior end; strictly dorsal, separated by $\frac{1}{2}$ the width of the back; anteriorly broadly, then narrowly lingulate, pointed, broadly attached, with a central axis containing 2 blood vessels connected by numerous transverse loops arranged in doubly pinnate fashion; branchiæ of a pair united with each other and with the corresponding notopodia by delicate transverse integumental folds.

Setæ all more or less tapering and acutely pointed. Neuropodials arranged in a dense phalanx, very numerous, rather stout, of two kinds, with transitional forms; those of the anterior ranks shorter, densely fibrillated, olive colored, strongly curved in a more or less sinuous manner, the edge corresponding to the principal convexity distinctly serrated with delicate transverse ridges partly encircling the shaft; those of the posterior ranks much longer, more slender, less strongly

curved, the exposed part lighter in color and spirally canaliculated around a slender fibrous core which usually appears to be somewhat eccentric.

Notopodial setæ in a dense spreading tuft, longer than neuropodials especially toward the dorsal margin of the bundles, but similar in form to the second kind, the spiral canal of smaller calibre, and corresponding to an external spiral raised line, which latter alone persists toward the end.

Setæ of posterior region few in number (only about 6 or 8 in the neuropodium), similar in both rami, very long, slender, straight and stiff, longitudinally striated, the terminal half with a delicate marginal serrature which appears to be due to a series of about $\frac{3}{4}$ collars slightly overlapping, and on one side separated from the shaft by a distinct space, thus foreshadowing the canaliculated form of seta.

A few short delicate setæ with bifid tips, the two divisions of which are fringed on their opposed faces with fine hairs, also occur in the neuropodium.

Anteriorly the neuropodial acicula are inconspicuous, but on the 13th to 16th parapodia inclusive they largely replace the ordinary setæ and become very much enlarged with subterminal thickenings, pointed ends, and a deep brown color; they project as a row of 5–7 short spines, except the dorsalmost one, which in most cases has its entire spindle-shaped terminal half exposed. In the posterior region there are 3 neuropodial and one notopodial acicula, slender, acute, with the tip sculptured for a short distance, exactly as in the setæ.

Suruga Bay, 3,709, 173–260 fms.; 3,724, 20 fms.; North Japan, 3,768, 25 fms.; 3,771, 61 fms.

CIRRATULIDÆ.

Cirratulus gibbosus sp. nov. (Pl. XXVI, fig. 72.)

Form of preserved specimens stout anteriorly, flat below, strongly arched above; slender, pointed, and much depressed posteriorly. The type and largest specimen has 105 somites, is 32 mm. long, and 6.5 mm. wide at XXX, the widest part.

Prostomium a short and broad lip about 3 times as wide as long, with a transverse row of 4 to 6 conspicuous, reddish-brown eyes on each side of a median interval of about $\frac{1}{3}$ the width of the prostomium. Mouth small. Peristomium a prominent, swollen, gibbous ring, as long as the prostomium and elevated above the level, both of this and the succeeding somites. Next follows a neck-like region of 6 very short somites without setæ or branchiæ. The succeeding few somites

widen abruptly and these and all others are uniannulate. Anus minute, slightly dorsal.

The branchiæ begin as a tuft of 3 or 4 small ones on each side of VIII just above the parapodia; on IX a large tuft of upward of 15 arises from a transverse area which extends from the parapodia nearly to the middle line, while each of the succeeding somites back as far as the beginning of the posterior $\frac{1}{3}$ bears a single pair which arises close to the posterior margin about midway between the parapodia and the dorsal mid-line, except anteriorly where the place of origin is lower and more irregular. Posteriorly the size of the branchiæ varies; small and large ones alternate in a very irregular way.

The parapodia consist of small, well-separated neuropodial and notopodial tubercles which begin with the setæ on VIII. For about the first 12 or 13 somites only capillary setæ are present in the notopodial tubercles, beyond that they are mixed with blunt spines, while all of the neuropodial tubercles contain both spines and capillary setæ. The number of both is always small, about 5 capillary in anterior notopodia, usually 2 of each in anterior neuropodia, 1 of each in posterior notopodia, and 1 capillary and 2 spines in posterior neuropodia. Capillary setæ little elongated, but few of them exceeding the distance between the two setigerous tubercles, pale greenish, slightly obliquely striated and fringed on one margin, slender, tapering. Spines simple, slightly sigmoid, greenish yellow, translucent and unstriated; one of the notopodials usually somewhat enlarged.

Sagami Bay, 3,703, 31 fms.

Chætozone spinosa sp. nov. (Pl. XXVI, figs. 73, 74.)

The type, a complete specimen of 112 somites, is 65 mm. long and 5 mm. in breadth at the end of the anterior $\frac{1}{3}$. The head is very distinctly separated from the body by a deep furrow behind the peristomium, broadly top-shaped as seen from above, bluntly pointed and about as broad as long. Prostomium nipple-shaped, separated from the peristomium by a furrow dorsally and laterally, but on the ventral side reaching back to mouth as a narrow pointed upper lip, behind which is a pair of palp-like lobes bounding the mouth at the sides. Peristomium much enlarged, considerably wider than the next somite and fully twice as long above as below; smooth, regularly rounded, with a faint transverse constriction above and laterally. No eyes and no visible sensory pits. Mouth ventral, with an anchor-shaped anterior extension between the palp-like lobes, bounded posteriorly by a smooth under lip.

Body somewhat depressed anteriorly, more or less quadrate posteri-

rly, tapering gradually from end of anterior $\frac{1}{3}$ both ways; both dorsal nd ventral surfaces smooth, the former depressed between the dorsal nds of the parapodia, by which it is sharply bounded, and than which is narrower, the latter wider, not depressed and passing gradually t the sides into the parapodia. Somites rather long, uniannulate, nd, with the exception of the first, very distinct and sharply marked y deep furrows; the first united broadly at the sides and by a narrow iedian dorsal tract to the peristomium, posteriorly rather indistinctly ›parated from the succeeding somite; it bears an achætous parapodium; ist 7 or 8 somites becoming rapidly smaller and the last 3 appar- ntly achætous. Pygidium prominent, expanded, somewhat funnel- iaped, and looking obliquely upward; anus in its centre.

Parapodia low but distinct, transverse lateral ridges equal to about of body circumference; anteriorly they are wrinkled and entirely ndivided, and pass without distinct boundaries into the ventral sur- ice, but sharply limited dorsally where they rise above the level of ie smooth area; farther back the dorsal delimitation becomes less nd less distinct and the parapodium becomes somewhat differentiated ito dorsal and ventral portions, which assume more divergent and rominent positions on the dorsal and ventral quadrants as the height the body decreases.

No branchiæ are in *situ*, but a few very long slender and much coiled aments in the bottle probably belong to this worm, while very dis- nct scars clearly indicate their disposition. Except about the last), each and every somite bears a pair of scars; anteriorly they are ›ry conspicuous, and the first, which is between the dorsal end of the it parapodium and the prostomium and probably belongs to the latter, much larger than the others. For about the next 17 somites the ars are at the extreme posterior margin of the somites and exactly i the level of the dorsal ends of the parapodia, but farther back, as e latter become less distinctly limited, the scars assume a progres- vely lower and then more anterior position, until in the posterior half the body they are just behind the lowermost setæ of the dorsal divi- ›n, or nearly at the middle of the parapodium. The posterior scars come smaller but remain quite evident to the last.

The setæ present a striking contrast to those of *C. abranchiata* owing the substitution in large part, for the delicate capillary setæ of that ecies, of stiff, brittle, spinous setæ which stand out in conspicuous iorls at the posterior end. In all parapodia the setæ are arranged a single vertical rank of two groups, although anteriorly the interval tween is so small that from the exterior they appear to be continuous.

The notopodial group is the larger, and both consist of a fan-shaped groups of two kinds of setæ intermixed, except in the last 20 or so somites where only one kind occurs. There are coarse, stiff bristles arranged at regular intervals, 8–10 in the dorsal, 6–8 in the ventral bundles, olive-green, densely striated and granulated internally, except toward the tip, curved, tapering rapidly to the attenuated outer $\frac{1}{3}$, which is colorless and fringed along one margin with overlapping hairs or plates. Very slender hair-like setæ are scattered among the coarse ones, and are 2 or 3 times as long as they, nearly colorless, with internal striæ having a slight spiral turn, continuously tapering, slightly enlarged at base of exposed portion, and provided, except near the base, with very delicate half-round scales which are rather distant, usually alternate on the two sides and toward the tip become reduced to minute cilia-like processes. Posteriorly the coarse setæ become much stouter, lose their delicate tips and form very prominent, slightly curved, blunt-pointed spines, while the capillary ones become smaller, and eventually disappear.

Sagami Bay, 3,698, 153 fms. Type only.

Chætozone (?) abranchiata (Hansen).

Under the name of *Cirratulus abranchiatus* Hansen described this species from much smaller specimens in which he found no trace of branchiæ. Otherwise his specimens closely resemble those collected by the "Albatross," which are referred to Hansen's species on the supposition that the types were imperfect. As this opinion may be erroneous a description is added.

Form short and very stout and thick in the contracted specimens, tapering about equally to the two ends which are similarly bluntly pointed; somewhat depressed with dorsal and ventral surfaces about equally convex and the parapodia forming a somewhat thickened marginal ridge. The type has 127 somites and is 38 mm. long by 8 mm. wide. The other specimen is larger.

Prostomium obtusely rounded, somewhat upturned, less than twice as broad as long; no eyes; mouth rather slit-like with lateral lips. Peristomium a simple ring not especially enlarged, resembling the next 2 somites which are much shorter than the prostomium but more than twice the length of the succeeding somites. First 3 somites achætous but not especially marked off from the succeeding ones, the increase in width being regular, though rapid; remaining somites short and uniannulate, the last few indistinct. Anus minute, dorsal, above a small tubercle-like pygidium.

'arapodia represented by small, simple neuropodial and notopodial ercles united by a slight transverse ridge. But very few of the nchiæ remain and the scars are so obscure that the arrangement he anterior end cannot be determined with certainty; for the greater t of the anterior ¾ of the body a pair springs from each somite just ve the notopodial tubercles but toward the end of the branchial ion the arrangement becomes somewhat irregular, the branchiæ ally occurring at intervals of 2 or 3 somites without change in ition.

'he notopodial and neuropodial tubercles each bears a tuft of 15–20 y soft elongated slender capillary setæ of a pale greenish color and logeneous vitreous structure; many of them exhibit an indistinct tened region of greater or less extent which appears more of the ure of an accidental crushing than a normal structure. These setæ exceedingly fine and long, very nearly equalling ½ the diameter even he much contracted body, and appear to the naked eye as conspi-us tufts of very fine whitish hairs. At the posterior end they are ewhat shorter but not enlarged or otherwise different. Compared h the capillary setæ of *C. spinosa* those of this species are less than he diameter and fully ½ longer, much softer and under an equal gnification lack altogether the surface markings of that species. uruga Bay, 3,726, 26 fms.; Sendai Bay, 3,767, 14–18 fms.

TEREBELLIDÆ.

phitrite bifurcata sp. nov. (Pl. XXVI, fig. 78.)

The type is 70 mm. long and 7.8 mm. in maximum diameter, and sists of 59 somites.

Prostomium a long prominent somewhat horse-shoe-shaped lip with-t complicating folds, but slightly rolled up and bent back against bases of the tentacles, behind which there is a low transverse ridge. eyes. Tentacles long, longitudinally grooved, in a continuous row about 22.

Peristomium a short simple ring, with a slightly free ventral margin ich covers the special lower lip, and no dorsal papillæ or compli-ing structures. Mouth large, with a wide lower lip besides the peris-nium.

The body, as usual in this genus, is somewhat enlarged anteriorly, re slender posteriorly, and throughout its length strongly arched ve and flat or concave below. Segments not very distinctly indi-ed and, except for a few biannulate anterior ones, only obscurely ulated. Somites II, III, and IV with their anterior margins more

or less freely produced at the sides and the latter 2 partly coalesced ventrally; no dorsal papillæ. Ventral plates 10, on somites V to XIV the first 9 narrow parallelograms, the last broadly elliptical and somewhat separated from the others. Anus large, terminal, its margin faintly wrinkled.

Branchiæ 3 pairs, on II, III, and IV, much branched, the number of divisions about equal on all, but somewhat shorter posteriorly. They have very nearly the form of the branchiæ of *A. johnstoni* Mgrn., and consist of a more or less bent and twisted main stem from which the filaments arise at intervals and divide dichotomously once, twice, or, rarely, even 3 times, or a few remain simple; the basal branches are long and slender, but the length gradually decreases until the apical ones are very short.

On the thoracic segments the parapodia are represented by rather broad ridges, the setigerous tubercle being merely a more prominent projection at its dorsal end slightly caudad of the line of the uncini. The second uncigerous torus is the longest, but the decrease in size is very slight to the last thoracic segment and is accompanied by a slight ventral shifting. The abdominal parapodia are rather large, fleshy and strongly bent, and bear a striking resemblance to the so-called false feet of a lepidopterous caterpillar, but posteriorly become more slender and sloping, and finally diminished in size; all are situated on the ventro-lateral angles of the body.

Capillary setæ occur on IV to XX inclusive, uncini from V to the pre-anal somite inclusive. The former have a narrow blade, nowhere exceeding ½ the diameter of the shaft, the blade fringed for about ½ its length, and a delicate smooth tip. The uncini are arranged in interlocking double rows of about 170 (XX) on the thoracic somites from XI to XX; on all others in a simple series directed forward; on each parapodium of somite XXX there are 80. Their bases are short with the internal margin strongly convex, the anterior end rounded, the posterior pointed, and a prominent subrostral process; the rostrum long, very acute, and strongly hooked, the sinus narrow, vertex much elevated with a prominent crest of at least five transverse rows of spines, of which the first contains 5 or 6 large ones and the last 8 to 10 small ones. The abdominal uncini are much smaller, with relatively shorter bases, the neck narrower and the crest higher, with more numerous rows of spines. The uncini are nearly colorless, the capillary setæ glistening yellow.

North of Sendai Bay, 3,768, 25 fms., type and one other specimen with portions of a thick mud tube.

Amphitrite cirrata Müller.

North Japan, 3,771, 61 fms., numerous specimens of small size.

Pista cristata (Müller) Mgrn.

Sagami Bay, 3,698, 153 fms.; North Japan, 3,771, 61 fms.

The branchiæ exhibit the usual asymmetry. The papillæ above the setigerous processes are on the posterior end of VI and VII, not on VII and VIII, as they are said to be in European specimens.

Scionella gen. nov.

Sides of the first 4 somites bearing prominent wings; a single pair of branchiæ arising from a transverse dorsal fold; setæ begin on IV.

Scionella japonica sp. nov. (Pl. XXVI, figs. 79, 80.)

The type, which consists of 49 somites, a few of the posterior ones having been lost, measures 70 mm. long and 5.5 mm. in greatest diameter. Rather slender, and only very indistinctly divided into thoracic and abdominal regions.

Prostomium a rather thick, prominent, trefoil-shaped fold, which projects stiffly out above and at the sides of the mouth, its margin somewhat rolled outward, a dorsal ridge behind the tentacles. No visible eyes. Tentacles at least 15 on each side, rather large, grooved longitudinally but in these specimens much contracted, broad and flat. Peristomium distinct all around, produced ventrally into a free margin, within which the rather large quadrate lower lip is visible, and which ends laterally in a pair of wing-like lateral lobes; dorsally very short, appearing as a mere ridge behind the tentacular ridge and bearing a dorsal pre-branchial tubercle on each side.

The 2d, 3d and 4th somites have no ventral folds but bear still more prominent wing-like lateral lobes, which rise successively to a higher level and overlap from behind. Those of somite IV are united across the dorsum by a high transverse fold which slopes upward and forward above III and bears the gills on its free edge. The next 10 somites are well marked, triannulate dorsally and with distinct ventral plates which undergo no change in form except that the last has roughly the form of an equilateral triangle. Somewhat large and swollen postbranchial tubercles occur above the parapodia on all somites of this region as far as XIV. The whole region is somewhat depressed, smooth, and convex above, flattened below, with distinct longitudinal grooves above and below the parapodia. The next 10 or 12 somites are large and their boundaries indistinct, while the remaining ones are sharply defined, shorter, and distinctly subdivided into annuli. Throughout the greater part of the abdominal region the dorsum is arched and the

venter flat, with a neural groove, but near the caudal end the body is more depressed.

The single pair of branchiæ, which arise as indicated above from the 4th somite, are large and conspicuous and divided into numerous filaments, which are so crowded that they appear to arise together from a common point, but which really spring in a unilateral pinnate fashion from a spirally wound stem. The latter makes about 3 turns, but owing to the closeness of the filaments, the bases of which are in actual contact, the number is somewhat uncertain. In line with the branchiæ somites II and III both bear dorsal tubercles, which are especially prominent on III, on which, in both specimens, a second smaller tubercle occurs at the base of the larger one; these are probably reduced gills, and, were it not for the exact correspondence of the two specimens, might be supposed to be regenerating.

On somites VI, VII and VIII short but prominent processes are present between the setigerous and uncigerous tori, just behind the setæ line. A small sense-organ may be found in a corresponding position in relation to most of the posterior parapodia.

Setæ begin on IV as a small tuft high up at the foot of the dorsal fold. On all remaining somites the parapodia are ventro-lateral, but as the uncigerous ridges are much longer on the anterior than the posterior thoracic somites, the slender setæ are at first more elevated in position, and gradually sink as the uncigerous tori diminish in extent. The abdominal parapodia have the base contracted and the dorsal angle somewhat produced.

Slender setæ are found on 17 somites, from IV to XX inclusive, are rather few in number, especially on IV, and are always arranged in a short compact vertical row. The shafts are pale yellow, fibrous, rather long, more or less strongly curved in a sigmoid fashion toward the end, with a mucronate tip, below which each side is provided for a short distance with a rather broad, delicately striated wing with entire margin terminated rather abruptly at its distal end. Different setæ differ greatly in their curvature and the extent of the wings, some being nearly straight with almost symmetrical wings, others almost angulated with the greatest width of the wings alternating. Uncini are found in all somites except the first four. In the thoracic region they face alternately backward and forward, and interlock in a double row, are nearly colorless, with short somewhat triangular bases, a short neck, narrow sinus, strongly hooked, stout, acute rostrum and an apical crest of 5 transverse rows of spines, the lowermost consisting of about 4, the others much more numerous, up to 10 or 12. In the abdominal region

on XII and XIII the plates are continued by an indistinct, much wrinkled and subdivided glandular area, while anteriorly both IV and III are glandularly thickened on the ventral surface. On the first 10 or 11 somites a smooth rounded glandular (?) elevation occurs on each side just dorsad and mediad of the notopodial tubercle; on the anterior postbranchial somites these tubercles run together into a low longitudinal ridge. Anus terminal, large.

There are 3 pairs of branchiæ on II, III and IV, the first somewhat the largest, and the third slightly the smallest, all beautifully arborescent, with about 6 main branches from a central stem, and numerous and fine subdivisions with a somewhat spiral arrangement, resulting in a rather acute conical form, which in life must be very beautiful and conspicuous.

The third somite bears a dorsal setigerous tubercle only on its dorsolateral angles; the next 16 have dorsal setigerous tubercles and ventral uncigerous tori. The latter are at first high up, but gradually assume a more ventral position, until the last 9 are almost entirely on the ventral surface, and the last 7 or 8 are separated by a median interspace not exceeding their own transverse extent, which increases from before caudad.

Slender setæ in a dense tuft, arranged more or less in the form of an arc or horseshoe open ventrally or anteriorly. They are of two kinds: simple colorless capillary setæ, not especially slender, and glistening straw-colored lance-shaped setæ, with strongly fibrillated shaft, and the end broadly margined on one side, narrowly on the other, both flanges reaching nearly to the tapering pointed tip, and marked with oblique fibrillæ, which sometimes wear into a slight fringe, especially on the broader margin.

On somites IV to XIX the uncini are arranged in 2 rows, opposite and facing each other, when retracted, in a groove; on the abdominal segments they form a single short row facing the head on the extreme end of the uncigerous process. Their number is very great in the posterior thoracic segments, the posterior row on XIX containing 260 and the anterior row evidently a considerably greater number. As in other species of the genus the uncini are broad, flat pectinate plates, the thoracic ones very constantly bearing 5 long sharp curved processes, with a rudimentary apical 6th, and a minute tooth between the first spine and the anterior muscular process of the base; the abdominal uncini have the 6th process usually well developed and the muscular processes more pronounced.

Suruga Bay, 3,723, 13–16 fms., type only.

Trichobranchus bibranchiatus sp. nov. (Pl. XXVII, figs. 83–85.)

The largest specimen has a length of 16 mm. for 29 somites, the caudal end being absent; the thoracic diameter is 2 mm.; almost double the abdominal.

Prostomium restricted to the region above the mouth, bilobate, consisting of a pair of rounded tentaculiferous cushions incompletely separated posteriorly. No eyes. Tentacles very numerous, forming a thick tangled mass above the mouth; they are of two forms, slender ones, which are by far the most numerous, arising from the entire margin of the cushions, and much larger ones, the ends of which are often broad and flat, whose origin is confined to the anterior and median region of the cushion border.

Peristomium simple, short above, much enlarged below to form a very high thick lip, the exact limits of which are uncertain owing to the partial protrusion of the buccal chamber. Connected with the peristomium and probably peristomial in origin is a pair of very wide, thin, delicately nerved, wing-like lobes, which arise on each side from beneath the prostomium and extend prominently laterally and anteriorly to a distance considerably exceeding the length of the prostomium. The remaining somites are regular and distinctly marked, without collars or lateral lobes to any of the anterior ones; the setigerous ones of 2 annuli, of which the anterior is usually the largest and bears the tori. The thoracic region, comprising the first 20 somites, is thick and quite terete, the abdominal suddenly contracted to ½ the diameter of the thoracic, and flattened or even longitudinally grooved on the ventral surface. Two pairs of simple unbranched gills arise from the dorsum of somites II and III; they are slender and tapering and their length considerably exceeds the greatest diameter of the body. The thoracic setigerous tori are elevated flattened tubercles, the uncigerous tori very small and low; abdominal uncigerous tori also very small but quite conspicuously elevated.

Slender setæ begin on VI and continue to XX, or for 15 somites. They form a short vertical rank of 14 to 20, usually in pairs of 1 large and 1 small seta. Setæ almost colorless, slightly curved, tapering, pointed, with entire tip and narrowly doubly winged margins. Uncini also begin on VI, and occur on all the following somites. They are always arranged in a single row, with their points directed forward and, on the thoracic somites, toward the dorsum; the series is slightly caudad of the slender setæ on the thoracic somites and begins almost in contact with them. The first torus (on VI) is short, and contains about 14 uncini, the number increasing to 32 on IX, and decreasing after XVI

to 23 on XX, the last thoracic somite. The thoracic uncini spread in a fan-shaped figure; they are colorless or pale brown, long, slender, with curved somewhat striated stem, increasing slightly in diameter to the surface of the body, then suddenly contracting to a narrow neck beyond which even more abruptly expanding into the remarkably bird-like head, with a blunt beak and a crest of 5 or 6 finely divided transverse rows of very numerous teeth, together having a nearly spherical form as viewed from above. The abdominal uncini number about 35 in the anterior somites, and are arranged in a marginal row about the torus, to the center of which the slender ligaments converge. They are nearly colorless, with short, broad, nearly triangular bases, upon which the only slightly expanded head is sessile; rostrum prominent and above it 2 or sometimes 3 transverse rows of numerous spines.

Station not given on label.

There is considerable conflict between the several published accounts of *T. glacialis* Mgrn., but the present species differs decidedly from those described from typical European localities in the entire absence of eyes, the wider cephalic wings, constancy of 2 pairs of gills, the form of the uncini and greater number of slender setæ.

Terebellides strœmi Sars.

The typical variety of this nearly cosmopolitan species occurs in Sendai Bay, 3,767, 14 to 18 fms., and probably in Suruga Bay, 3,724, 20 fms.

Var. japonica nov.

All of the specimens of *Terebellides* taken in Sagami Bay differ from the typical variety in having a much smaller number of prostomial tentacles and wider margins to the slender setæ. They have a length up to 70 mm. The proportions of the gill lobes vary considerably; and in one example from 3,704, the posterior lobes are undeveloped.

Sagami Bay, 3,695, 175–190 fms., types; 3,698, 153 fms.; 3,704, 94 fms.; 3,738, 167 fms.

AMPHARETIDÆ.

Amphicteis japonica McIntosh.

Two fine specimens taken at station 3,771 are much larger than those originally described by McIntosh from south of Yedo; they measure 45 mm. in length. The branchiæ are perfect and are round as in *A. gunneri*, not flattened as doubtfully stated by McIntosh; the uncini are also somewhat narrower than is figured for the types, but other specimens conform exactly to the originals in this respect. The tube is tough and parchment-like, and covered with a thick coating of fine silt.

Sagami Bay, 3,698, 153 fms.; Sendai Bay and northward, 3,767, 14–18 fms.; 3,771, 61 fms.

AMPHICTENIDÆ.

Cistenides hyperborea Mgrn.

Off Kamchatka this species was found in very great numbers on a soft muddy bottom in shallow waters, and a single small example in Sendai Bay. The paleoli vary somewhat in number and length, but are almost invariably 12 or 13 on each side. In the specimens from station 3,777 they are so thickly incrusted with a brownish deposit as to appear club-shaped.

Sendai Bay, 3,767, 14–18 fms., one small example; off Kamchatka, 3,776, 3,777, 3,780, 12–13 fms.

MALDANIDÆ.

Nicomache (?) inornata sp. nov. (Pl. XXVII, figs. 86, 87, 88.)

Head and 14 anterior setigerous somites only known, these having a length of 55 mm. and a diameter of 3 mm. Owing to the absence of the anal funnel the generic reference is doubtful, the form of the setæ having chiefly led to the selection of *Nicomache* rather than *Lumbriclymene* or a related genus.

Prostomium and peristomium completely coalesced into a rather slender head, which is twice as long as thick and truncated at a rather acute angle; prostomial lobe or palpode pointed, curved dorsad, continuous with both median ridge and lateral margins of cephalic plate; cephalic plate indistinct, its posterior half somewhat gibbous, the anterior concave, passing with rounded margins into the dorsal and lateral surfaces of the head, no produced marginal folds; median ridge about ½ length of cephalic plate, rather low and broad, passing anteriorly into palpode, posteriorly indistinctly into gibbous portion of head; sensory grooves well marked on each side of ridge and external to these again triangular depressed areas bounded by the lateral margins of cephalic plate. Peristomial region of head slightly compressed; mouth rather large, ventral, bounded posteriorly by a prominent pouting, but rather narrow, lip.

First 4 setigerous somites short, cylindrical, decreasing slightly in length, each with an anterior annular ridge just in front of the seta line; succeeding segments longer and more slender, but never much elongated, boundaries very obscure after VIII; somites VI to IX with anterior glandular rings but no distinct collars; all somites except the first 5 more or less marked with lateral vertical grooves and folds. Head and anterior region of body very smooth. Tori indistinct and laterad on anterior somites, thick swollen and more ventral after IX.

Capillary setæ of 2 kinds, both few in number, in the dorsal bundles; those found on all setigerous somites are relatively large, fibrillated, tapering, the tips acute and sometimes curved, with a short distinct flange on one side. Fringed capillary setæ are found in the middle somites; colorless, very slender, with elongated tips, with rather widely separated, short hairs closely appressed to, and usually arranged in pairs on both sides of the shaft of the seta. Farther back these are replaced by setæ which are doubly winged at the base of the exposed portion, beyond which are extremely long faintly fringed capillary tips.

Crochets yellow, with curved tapering fibrous stems, which are not shouldered and only slightly enlarged at the surface of the body; exposed portion long and slender, the head not much enlarged, but provided with a very long, sharp beak, the tip of which is slightly recurved; accessory teeth 4 to 6, the first large and typically standing sharply apart from the beak, the others also slender and distinct, except the 1 or 2 smallest, which are more obscure and fibrous; guard greatly developed, in 2 lateral halves, each formed of about 23 strong hairs joined together above the teeth by a membrane-like band beyond which the hairs are much finer and may constitute a delicate fibrillated web, arching over the basal half (not the tip) of the principal hook and meeting the opposite half of the guard above; no distinct subrostral process. On somite V the crochets are only bent, not hooked, with one large and one smaller blunt vitreous process, and a group of small fibrous ones; guard, if perfect in the example studied, consisting of a few gently curved subrostral hairs reaching only as far as the point of the principal spine.

Acicula bright yellow, one each on ventral side of tori of II, III and IV, stout, tapering to a blunt point, and fibrous.

Tubes fragile, of coarse, dark-colored sand grains and bits of shell.

Suruga Bay, 3,713, 65 fms.; 3,725, 13 fms., type.

Clymene mirabilonga sp. nov. (Pl. XXVII, figs. 89–93.)

Head uniannulate, the prostomium and peristomium completely united, short, somewhat compressed, vertical diameter equal to greatest length on ventral side; mouth ventral, large, bounded posteriorly and laterally by a rugous crescentric fold, anteriorly by the wrinkled base of the rather narrowly triangular, pointed, prostomial lobe or palpode; cephalic plate very broad, nearly orbicular when the limbate margin is spread, broadly oval when viewed from above with margin in normal position, the margin divided by a pair of clefts into anterior and posterior lobes, of which the latter is $\frac{2}{3}$ as long as the former; posterior lobe suberect, faintly divided by median and lateral emargina-

tions into 4 slightly marked sub-lobes; anterior lobes also suberect, much higher than posterior, with smooth, rounded, entire margins anteriorly meeting the palpode, from which they are separated by a distinct sulcus; median ridge nearly $\frac{3}{4}$ length of cephalic plate, very narrow, high and prominent, with a sharp compressed summit, of equal width throughout, ending anteriorly in a short palpode about 3 times its width but still narrow; sense organs bounding median ridge rather broad, shallow depressions, included with the ridge in a narrow lyre-shaped area occupying the middle $\frac{1}{3}$ of the cephalic plate exclusive of the limbate margin, with its base dorso-caudad, while the arms fade out anteriorly to the sides of the palpode.

Head and anterior somites divided into numerous small raised areas which under a lens have an appearance and lustre like the human skin. First 4 setigerous somites short, diameter and length about equal, and length slightly decreasing to the 4th, first very broadly attached to the peristomium; from the 5th setigerous somite (VI) the length increases to X, though IX, which is separated from X only by a very obscure furrow, is somewhat shorter than VIII; no specially developed collar, though each anterior somite is extended into a low fold which somewhat embraces its predecessor, and which is strongly glandular on VII, VIII and IX; last 3 setigerous somites (intervening ones unknown) decreasing in length, cylindrical, the last in this specimen much shorter than thick, but probably it and the following achætous somites are considerably contracted; 2 preanal and anal somites very short, slightly telescoped, with posterior margin prominent, and on the anal somite forming a sharp annular shoulder from the center of which the anal funnel arises. Anal funnel with a short stalk, having a diameter of about $\frac{1}{2}$ the body of the anal somite, but spreading in a low corolla form to the diameter of the latter, in length equalling the anal and one preanal somite; its margin regularly denticulate with 43 regular, pointed, triangular teeth longer and narrower than those of *Axiothea campanulata*, with an occasional one bifid, and none in the neural line, which is very distinct to the edge of the funnel; anus central, surrounded by minute papillæ and radiating ridges, but not elevated on a large central papilla. The relation of the funnel to the anal somite in the type specimen is probably due largely to contraction.

First eight setigerous tori on anterior end of somites, the others posterior; anterior tori very low and obscure, becoming swollen and conspicuous by X; on last 3 setigerous somites prominent and reaching well ventrad, where they are separated by a median distance of about $\frac{1}{3}$ their length, the interspace being occupied by a glandular area;

tori and glandular areas remain on the 2 preanal somites, and also slightly indicated on the anal but bear no setæ.

Peristomium and last 3 somites without setæ. First 3 setigerous somites with a dorsal tuft of slender setæ and a single ventral aciculum, but no crochets; other setigerous somites with a small dorsal fascicle of slender setæ and a ventral series of crochets, the number of which increases for several somites caudad.

The resemblance between the setæ of this species and *Nicomache capensis* is noteworthy. Slender setæ of 3 forms, the first, which occurs on all setigerous somites, is pale greenish-yellow, with a core of parallel fibres, long, tapering, with a distinct wing on one margin and a much narrower one on the other, both leaving a long very fine tip free. The second form is confined to an undetermined number of anterior somites as far as X; colorless, exceedingly slender and very delicately doubly fringed. The third form is found only posteriorly, the anterior limit being undetermined; colorless, with a long, slender shaft of nearly uniform diameter, the terminal part of which bears rather broad chaff-like bearded processes, the exact arrangement of which cannot be determined but appears to be singly spiral toward the tip, paired toward the base, the whole closely resembling the fruiting head of certain grasses.

Anterior acicula simple, stout, pointed, slightly curved fibrous spines of a yellow color.

Crochets yellow, with slender, tapering, curved, very fibrous stems, strongly shouldered at surface of body, then constricted to a narrow brittle neck, and again expanded terminally into a coarse broad head; terminal part unusually prominent and consequently frequently broken off; principal hook prominent, acute, rather slender and, except at the base, non-fibrillated; supported and surmounted by 4–6 spines, of which the first is large and vitreous, the others much smaller and, like the expanded portion of the head, strongly fibrillated; beard greatly developed, consisting of a transverse row of a small number of tapering sickle-shaped hairs which arise from a stout transverse basal plate, supported on a slight subrostral shoulder, and curve high over the apex of the principal hook to end in fine curled tips above its base. The anterior crochets differ only in the position of the beard, which arises much closer to the rostrum than in the more posterior ones, and in their somewhat smaller size.

The head and tail ends of the type specimens were found several miles apart.

Suruga Bay, 3,714, 60 fms., head; 3,725, 13 fms., caudal end.

aldane sarsi Mgrn.

This species has already been recorded by McIntosh from south of edo and by Wirin from the Vega collections in Bering Sea. The Albatross" examples are of small size and are referred somewhat oubtfully to this species as they differ from the published figures id descriptions in several respects. The palpode is much broader ith very numerous eyes, the cephalic plate inclined to the longitudinal cis at a very acute angle, the median ridge posteriorly depressed and oscure, the anal plate broader and each dorsal angle of the ventral be produced into a distinct spine. There are also some peculiarities ' the setæ. The anterior end, and especially the head, is generally osely spotted with reddish-brown.

Sagami Bay, 3,695, 175–190 fms.; 3,798, 153 fms.

aldane coronata sp. nov. (Pl. XXVII, figs. 94, 95, 96.)

This is a large species, the type of which measures 130 mm. long by mm. in greatest diameter in a contracted state, while fragments f other specimens from the same locality are more than twice as arge, so that a length of 300 or 400 mm. in life is not improbable.

Head acute, cephalic plate narrowly ovate, produced anteriorly into a pointed thin process or palpode, limbate margin prominent, divided on each side by a lateral cleft which passes into a deep slit on the side of the peristomium; the. posterior half high, erect, its margin coarsely serrate with 15–22 teeth, which are large anteriorly, and progressively diminish in size toward the dorsal mid-line; anterior half lower, more spreading, passing into the anterior palpode without sharp demarkation, its margin bearing on each side from 4 to 7 (commonly 5) stiff processes, decreasing in size from behind forward, and the largest about ½ the width of head, often asymmetrical and sometimes bifurcated; median ridge moderate, about ½ cephalic plate, its posterior end about opposite the most anterior marginal process, anteriorly ending in much broader palpode, rather low and wide but prominent and sharply defined by deep, narrow, sensory grooves. Peristomium short, biannulated by the deep lateral grooves above alluded to, which cut off a small incomplete anterior ring.

All following preanal somites (19 in number) are setigerous; II to V short and biannulate, the anterior annulus the larger; VI and VII transitional, the others uniannulate and elongated, the last few diminishing somewhat in length, the furrows indistinct.

Anus dorsal, external to funnel, between this and a prominent integumental fold which covers it. Anal funnel very large, divided by a pair of oblique lateral clefts into dorsal and ventral lobes; ventral

lobe the smaller but constituting most of the funnel proper, its marg variable in exact shape, but always somewhat uneven and irregula crenulated or slightly toothed; dorsal lobe much more prominent an consisting chiefly of a large, flaring platform-like structure each sid of which has 3 blunt angular marginal prominences, bearing as man slender filamentous processes nearly as long as the anal funnel. On very large specimen, of which only the posterior end is preserved, differs in having the ventral lobe very finely denticulated, the dorsa less flaring, with an even margin and bearing 11 filaments muc shorter than usual. It may prove to be representative of a distinc species as other specimens of nearly equal size are quite typical i these respects.

On the first 4 setigerous segments the setæ are borne on thin wing-like vertically elongated ridges, on the remainder on thick swollen tori, which are especially prominent on VII, VIII and IX and on XVII, XVIII and XIX; on V, VI and VII the tori are united by transverse ventral thickenings, but elsewhere are quite distinct and entirely lateral. The tori are anterior on the first 9, posterior on the remaining setigerous somites.

Somite II bears only capillary setæ, III, IV and V a small ventral series of about 6 or 7 crochets, in addition to the slender setæ, the other somites long ventral series of crochets, varying from 37 to 41 in each group on specimens of average size, and a small dorsal tuft of slender setæ.

Capillary setæ have a hyaline cortex and a slightly yellowish fibrous core, the more superficial fibres of which are very accurately parallel, tip very acute but tapers mostly in the middle ⅓ of its exposed part; wingless on the first setigerous somite, but farther back the cortex is produced into a narrow flange on the dorsal side.

Crochets stout, stems long, curved, tapering, with a distinct shoulder at the surface of the body and beyond it a narrow region which gradually broadens into the beaked head. Those of the posterior regions have a strong transparent hook, the base of which is concealed in a hood-like covering of fibrillated spines which rise into a crest of four principal teeth; guard poorly developed, of only 8 or 10 curved hairs united for a considerable part of their length by an intervening delicate web; subrostral process small. Anterior crochets on II to V much less strongly hooked; those in the middle of the series with a large terminal process bent nearly at right angles to the shaft, about 4 smaller fibrous processes, and a beard; the dorsalmost similar but only slightly bent.

Color uniform pale grayish-brown; tori pinkish-orange.

what in shape. Typical uncini with rather slender curved internally fibrous stems, without a distinct shoulder but rather gradually thickened on one side, external to the body contracted in diameter and bent dorsad, then broadly expanded into the terminal head, which is provided with one very large scarcely fibrous hook supported by usually 4 successively smaller fibrous ones, which do not form a cap-like structure; guard or beard moderately developed, consisting of about 20 stiff slightly curved hairs, somewhat divergent from a prominent subrostral process and enclosing the tip of the principal hooked process.

The type only known from Suruga Bay, 3,739, 55–65 fms.

CHLORHÆMIDÆ.

Stylaroides borealis (Hansen).

A single specimen which conforms closely to the description of this North Atlantic species, but is fully three times the length of the original specimens taken off the coast of Norway, was dredged at station 3,775, North Japan, in 57 fms.

STERNASPIDÆ.

Sternaspis scutata (Ranzani) Otto.

The only difference which can be detected between these and European specimens is that the gill plates of the former are slightly more prolonged anteriorly.

Suruga Bay and vicinity, 3,709, 173–260 fms.; 3,739, 55–65 fms.

Explanation of Plates XXIII, XXIV, XXV, XXVI, XXVII

Unless indicated otherwise all setæ figured are from somite X or that immedi... te neighborhood.

Plate XXIII, Fig. 1.—*Eumidea cæca*, terminal portion of a neuropodial set... × 480. 1*a*, the articulation of the same, × 820.
Fig. 2.—*Polynoa semierma*, middle neuropodial. × 332.
Fig 3.—The same, dorsal neuropodial. × 332.
Fig. 4.—*Scalesetosus formosus*, dorsal neuropodial. × 480.
Fig. 5.—*Scalesetosus formosus*, ventral neuropodial, outline only. × 480
Fig. 6.—*Scalesetosus formosus*, notopodial. × 480.
Fig. 7.—*Lepidonotus branchiferus*, middle neuropodial. × 130.
Fig. 8.—*Lepidonotus branchiferus*, guard of a neuropodial seta in process ... being shed. × 130.
Fig. 9.—*Lepidonotus branchiferus*, portion from the middle of a notopodi... × 586.
Fig. 10.—*Lepidonotus chitoniformis*, middle neuropodial. × 130.
Fig. 11.—*Lepidonotus chitoniformis*, portion of a notopodial. × 586.
Fig. 12.—*Lepidonotus cœloris*, middle neuropodial. × 332.
Fig. 13.—*Lepidonotus vexillarius*, dorsal notopodial. × 480.
Fig. 14.—*Lepidonotus vexillarius*, portion of middle notopodial. × 480.
Fig. 15.—*Lepidonotus vexillarius*, ventral neuropodial. × 332.
Fig. 16.—*Hylosynda carinata*, middle neuropodial. × 332.
Fig. 17.—*Hylosynda carinata*, notopodial. × 332.
Fig. 18.—*Hylosynda magnacornuta*, middle neuropodial. × 110.

Plate XXIV, Fig. 19.—*Lætmatonice pellucida*, notopodial. × 74.
Fig. 20.—*Lætmatonice pellucida*, neuropodial. × 74.
Fig. 21.—*Restio ænus*, stout neuropodial. × 332.
Fig. 22.—*Restio ænus*, slender neuropodial. × 332.
Fig. 23.—*Restio ænus*, slender seta from anterior rank. × 332.
Fig. 24.—*Restio ænus*, capillary seta. × 332.

All of the setæ figured in figs. 21–24 are from somite XV.

Fig. 25.—*Nereis pusilla*, middle notopodial. × 480.
Fig. 26.—*Nereis pusilla*, ventral neuropodial. × 480.
Fig. 27.—*Nereis pusilla*, stout neuropodial from a posterior foot. × 4...0.
Fig. 28.—*Nereis paucidentata*, typical notopodial. × 480.
Fig. 29.—*Nereis paucidentata*, ventral neuropodial. × 480.
Fig. 30.—*Nereis paucidentata*, stout posterior neuropodial. × 480.
Fig. 31.—*Aricia fimbriata*, one of the stouter anterior neuropodials. × 3...32.
Fig. 32.—*Aricia fimbriata*, a slender anterior neuropodial. × 332. 32*a*. A portion of the same. × 586.
Fig. 33.—*Aricia fimbriata*, portion of a canaliculated posterior neuropo...ial represented as seen in optical section. × 820.
Fig. 34.—*Aricia fimbriata*, portion of a capillary posterior notopod...al. × 820.
Fig. 35.—*Aricia fimbriata*, an incomplete bifurcated notopodial. × 586.

Plate XXV, Fig. 36.—*Eunice northioidea*, compound seta from the middle of bundle. × 480.
Fig. 37.—*Eunice northioidea*, pectinate seta. × 480.
Fig. 38.—*Eunice northioidea*, uncinus from posterior foot. × 332.
Fig. 39.—*Eunice quinquifida*, compound seta from middle of bundle. × 480.
Fig. 40.—*Eunice quinquifida*, pectinate seta. × 480.
Fig. 41.—*Eunice quinquifida*, uncinus from LX. × 332.
Fig. 42.—*Eunice mucronata*, compound seta from X. × 480.

Fig. 43.—*Eunice mucronata*, compound seta from LVI. × 480.
Fig. 44.—*Eunice mucronata*, pectinate seta. × 480.
Fig. 45.—*Eunice mucronata*, uncinus from XLI. × 332.
Fig. 46.—*Eunice gracilis*, compound seta. × 480.
Fig. 47.—*Eunice gracilis*, pectinate seta from XLI. × 480.
Fig. 48.—*Eunice gracilis*, uncinus from posterior foot. × 332.
Fig. 49.—*Eunice medicina*, compound seta. × 480.
Fig. 50.—*Eunice medicina*, pectinate seta. × 480.
Fig. 51.—*Eunice medicina*, uncinus from LV. × 332.
Fig. 52.—*Paranorthia brevicornuta*, compound seta from 3d foot. × 820.
Fig. 53.—*Paranorthia brevicornuta*, compound seta from 4th foot. × 480.
Fig. 54.—*Paranorthia brevicornuta*, simple marginal seta from 10th foot. × 332.
Fig. 55.—*Paranorthia brevicornuta*, pectinate seta from 13th foot. × 480.
Fig. 56.—*Paranorthia brevicornuta*, uncinus from 11th foot. × 480.
Fig. 57.—*Northia geophiliformis*, part of appendix of compound seta, from IV. × 480.
Fig. 58.—*Northia geophiliformis*, pectinate seta from XXXV. × 480.
Fig. 59.—*Northia geophiliformis*, uncinus from XL. × 480.
Fig. 60.—*Onuphis cirrobranchiata*, margined seta from dorsal ramus of XII. × 332.
Fig. 61.—*Onuphis cirrobranchiata*, uncinus from V. × 332.
Fig. 62.—*Onuphis cirrobranchiata*, uncinus from XXVII. × 332.
Fig. 63.—*Onuphis cirrobranchiata*, funnel-shaped seta from XII. × 480.

ATE XXVI, Fig. 64.—*Laranda robusta*, seta from dorsal group of XX. × 130.
Fig. 65.—*Laranda robusta*, aciculum and seta from ventral group of a posterior somite. × 130.
Fig. 66.—*Notocirrus zonata*, seta from dorsal group of a middle somite. × 332.
Fig. 67.—*Notocirrus zonata*, one from ventral group of same. × 332.
Fig. 68.—*Ninoe palmata*, marginal seta from ventral bundle of XII. × 332
Fig. 69.—*Ninoe palmata*, similar one from dorsal bundle of XC. × 480.
Fig. 70.—*Ninoe palmata*, margined and hooded uncinus from ventral bundle of XII. × 480.
Fig. 71.—*Ninoe palmata*, uncinus from XC. × 480.
Fig. 72.—*Cirratulus gibbosus*, a notopodial group of one blunt spine and one delicate fringed seta from LX. × 130. *a*, portion of the latter. × 586.
Fig. 73.—*Chætozone spinosa*, from XXV. × 130. *a* and *b*, enlarged portions of the two setæ at the points indicated. × 586.
Fig. 74.—*Chætozone spinosa*, spine from XCVI. × 130.
Fig. 75.—*Goniada foliacea*, a compound neuropodial of average length. × 586.
Fig. 76.—*Goniada foliacea*, a notopodial from L. × 586.
Fig. 77.—*Goniada distorta*, a compound neuropodial seta. × 332.
Fig. 78.—*Amphitrite bifurcata*, an uncinus. × 332.
Fig. 79.—*Scionella japonica*, an average margined seta from the middle of the bundle. × 332.
Fig. 80.—*Scionella japonica*, an uncinus. × 332.

ATE XXVII, Fig. 81.—*Loimea arborea*, a margined seta from XV. × 110. *a*, portion of the same. × 586.
Fig. 82.—*Loimia arborea*, uncinus from XV. × 332.
Fig. 83.—*Trichobranchus bibranchiatus*, slender seta. × 332.
Fig. 84.—*Trichobranchus bibranchiatus*, uncinus. × 820.
Fig. 85.—*Trichobranchus bibranchiatus*, uncinus from XXII. × 820.
Fig. 86.—*Nicomache*(?) *inornata*, portion of capillary seta from XV. × 480.
Fig. 87,—*Nicomache*(?) *inornata*, end of crochet from XV. × 332.
Fig. 88.—*Nicomache*(?) *inornata*, end of crochet from V. × 332.
Fig. 89.—*Clymene mirabilonga*, simple capillary. × 74.
Fig. 90. *Clymene mirabilonga*, pinnately fringed capillary. × 480.

Fig. 91.—*Clymene mirabilonga*, spirally fringed capillary. × 110.
Fig. 92.—*Clymene mirabilonga*, entire crochet from a posterior thoracic segment. × 32.
Fig. 93.—*Clymene mirabilonga*, terminal portion of the same. × 332.
Fig. 94.—*Maldane coronata*, capillary seta from III. × 110.
Fig. 95.—*Maldane coronata*, end of dorsal crochet from III. × 332.
Fig. 96.—*Maldane coronata*, entire crochet from X. × 332.
Fig. 97.—*Axiothea campanulata*, capillary seta from II. × 110.
Fig. 98.—*Axiothea campanulata*, entire crochet. × 74.
Fig. 99.—*Axiothea campanulata*, exposed portion of the same. × 332.

SUPPLEMENTARY NOTES ON AN ANT.

BY ADELE M. FIELDE.

In a preceding paper,[1] I described experiments showing that when pupæ and the ant-workers hatching therefrom are maintained in segregation, such ants refuse to affiliate with workers of their colony who are forty days or more older than themselves; and that ant-workers thus reared in segregation will not accept a queen much older than their mother. I believe it to be proven that the cause of the hostility of one colony to those of another colony of the same species and variety[2] is a difference of contact-odor coincident with difference of age in the individuals composing the colony. The queen-mother alone determining the inherent primitive odor of each of her offspring.

I recently undertook the herein recorded experiments with a view to ascertaining whether any of the rays of light to which the ants are exposed in seeking food so affects their metabolism as to produce that difference of odor which is the cause of hostility between colonies of different age.

On August 21, 1902, I put five queens and 200 workers, all of one colony and without young, into each of five new Fielde nests.[3] All

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[1] "Notes on an Ant," *Proceedings of the Academy of Natural Sciences of Philadelphia*, December, 1902.

[2] The ants used for the experiments described in that paper and in the present writing were *Stenamma fulvum piceum*.

[3] "Portable Ant Nests," *Biological Bulletin*, Vol. 2, No. 2, 1900. An improvement suggested by Dr. W. M. Wheeler in the making of these nests may be read about in a note in his paper, "Ethnological Observations on an American Ant," 1903. He uses Diamond Cement for joining the glass portions of the nests. Should that cement not be easily obtainable, Major's cement is also better than glue. I used for one year a nest stuck together by Major's cement, and then immersed the nest in water for two weeks without loosening the glass parts.

Dr. Wheeler also suggests the use of mica instead of glass in covering the hallways or passages between compartments. I have found celluloid film also better than the glass, and it is tougher than the mica.

It is better to darken the nest by glueing black cloth over the outside walls rather than by painting them, the cloth being more effective and more durable than the paint.

I also find that if a thin pane of orange-colored glass be used for the roofing, instead of the transparent glass, the ants are little disturbed by the lifting of the opaque outside cover, and that their behavior may then be studied with assurance that it is the same as when they were in darkness.

The ideal ant-nests would, I think, be secured were the patterns of the Fielde nests reproduced in white porcelain. Such nests, topped with Turkish towelling, which can easily be renewed when soiled, and with a roofing of orange-colored

the ants were freshly captured from a single wild nest. My first artificial nest was roofed with transparent glass, and is hereinafter referred to as the white nest. The second nest was roofed with double panes of indigo glass, transmitting no light-rays lower in the spectrum than blue. The third nest was roofed with double panes of blue and purple glass, transmitting no light-rays lower than blue, and showing under the spectroscope a very broad band of violet. As the ants in the second and third nests behaved nearly alike, I shall refer to these two nests as the violet nests. The fourth nest was roofed with double panes of orange glass, transmitting only red and green rays, and this nest is referred to as the orange nest. The fifth, the dark nest, had an opaque roofing. All the nests were kept on a table in the diffused daylight that entered a large window, underneath a gas-jet that burned several hours at night. The temperature and the humidity were nearly alike for all the nests, and the same food was supplied to all on the same days. There was never any communication between the nests.

From the beginning, the ants in the white nest and in the violet nests behaved alike in their efforts to seek shelter from the light-rays entering their respective abodes. At first they packed themselves into the hallways, coming out only at night or in very cloudy days for food. The ultra violet rays entering the white and the violet nests, were those that drove the ants to shelter. These rays are invisible to the human eye, and are not shown by the spectroscope; but Forel's ants,[4] *Formica sanguinea* and *Formica subsericea*, withdrew from the isolated ultra-violet rays as from full daylight. For the logic of my experiments the isolation of the ultra-violet rays was not required. There is no doubt that the ants instinctively withdrew from the ultra-violet rays, and that they are indifferent to all the other light-rays. My experiments show that they become fearless of, but not insensible to, these ultra-violet rays, the time required therefor being in direct ratio to the intensity of the illumination from the ultra-violet rays.

It was not until December, 1902, that my ants gave sign of having ceased to fear these rays when in charge of the young. In the night and in cloudy days they brought the inert young out to occupy the sponges in the center of the compartments. Toward the end of January, 1903, the ants in the violet nests occupied the middle areas of their

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glass, so tinted as to exclude light-rays above blue in the spectrum, would conduce to the serenity of the ants and facilitate the study of their ways. Cleanliness, the right degree of humidity, pure air and a varied diet presented in minute quantities, enables the ants to live long and prosper in these nests.

[4] "Ueber die Empfindlichkeit der Ameisen für Ultra-violett und Röntgen'sche Stralen," Prof. A. Forel und Prof. H. Dufour, *Zoologischen Jahrbüchern*, 1902.

rooms as serenely as did the ants in the dark nests, with whom they were frequently compared. In the white nest the ants did not bring their young out upon the sponges, in bright daylight, until the end of February.

In the orange nest, on the contrary, the ants behaved from the beginning as did those in the dark nest, never huddling in the hallways nor seeking the shade of the walls. They often clustered in the most highly illuminated portions of the area. All the actions of the ants indicated that they were insensible to the red and green rays.[5]

As the nests were new and nearly alike in structure, temperature and humidity, there seems to have been no reason other than that which lay in the difference in light-rays, for the difference in the behavior of the ants in the different nests, those in the white and the violet nests behaving nearly alike, and those in the orange and the dark nests behaving wholly alike. The point to be here noted is that the ants in the white and the violet nests learned to be unafraid of the rays that at first drove them into corners. After ten months' exposure to these rays they were still sensitive to them, preferred shelter from them, and would soon move to a room of which I changed the roofing to such as covered either the orange or the dark nest; but they appeared to have learned that those light-rays were innocuous. Not only, then, can these ants become acquainted with human beings, lose fear of them and cease to sting them; not only can they become acquainted with ants of alien families and thereupon cease to quarrel with them, but they can become unafraid of certain light-rays and adjust their behavior to conditions to which they were instinctively averse. They are susceptible to education through the eye as well as through the sense of smell.[6]

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[5] *Formica subsericea, Cremastogaster lineolata, Lasius umbratus* and *Lasius latipes* behave in the same manner toward these rays.

[6] Something that appears purposeful in the behavior of my ants is their carrying of morsels of hickory-nut or other dry substance and dotting with it the surface of a lump of Turkish paste or other viscid sweet that they like to eat. They then stand with clean feet on the stepping stones that they have laid and lap the sticky food. Oftentimes the sticky sweet is the only one among several kinds of food in their food-room that is flecked by these bits of nut. It may be that ants enaged in carrying morsels of food come upon something more luscious, and drop the former in order to enjoy the latter. They are apt to give special attention to any new dainty.

Dr. Wheeler, on p. 18 of the paper referred to in note 3, says of his *Leptothorax* that "isolation brought out an instinct which is common to all ants known to me except *Polygerus*, ... the instinct that impels them to collect dead sister ants, little particles of earth, etc., and to deposit them on liquid food in the manger." When cleaning up their dwellings, as my ants do, carrying particles to the rubbish-pile, as is their wont, diversion of their attention will often cause them, as it will cause monkeys, to drop the thing they carry. The same or another ant may pick up the dropped particle, if it be not beyond recovery. They hold more tenaciously to the young that they have in charge.

In all five of the nests I watched the rearing of progeny from the deposit of the eggs through the larval and pupal stages to callows. In the violet nests the young were as numerous and as advanced in development at any one period of time as were the young in the orange or the dark nest. It is certain that eggs, larvæ and pupæ may pass their whole career normally and may develop into healthy callows, spending all the daylight hours under rays from which the ant-nurses instinctively withdraw them. The base of the instinct must therefore lie in something other than injury done to the young by these rays.

In the latter part of June, 1903, the ants having been ten months in these nests, I introduced into each of the five nests one queen and five adult workers, all marked, from each of the other four nests. The ants were introduced one by one, and were watched for some minutes thereafter until the manner of the reception of each was ascertained. In no case was there sign of animosity toward an ant that had lived ten months in daylight, in light-rays of another color, or in the dark. After twenty-four hours spent with their ancient comrades, all the marked ants were alive and were taking part in the care of the young. Later, I distributed all the ants in the five nests equally in two other nests and they continued in peaceful association together. These ants had not lost their aversion to aliens, for, when I introduced such, they were soon torn in pieces. *Ten months' residence in the light of day, or under light-rays of different wave-length, does not cause a difference of contact-odors in the adult ants.*[7]

Twenty callows reared in the violet nests from the deposit of the egg upward,[8] were segregated under violet rays in a Petri cell, for two weeks, that they might separately establish their nest-odor, and become engrossed in the care of young. Twenty callows reared in the orange nest from the deposit of the egg upward were likewise segregated under orange glass for two weeks. On the 12th of June I transferred, one by one, about half the ants in each cell to the other cell. All were received amicably and were permitted to share in the care of the young. *The*

[7] The color of the ants was not noticably altered by exposure to any of these rays. All the callows acquired color like those in the dark nest.

[8] Although the fact has no bearing upon the present series of experiments, as all the callows in these nests were presumably the issue of queens, I here note one of the records of the last few months. Four workers, of whom one was major, two minor, one minim, were hatched from pupæ segregated in one of my Petri cells, in August, 1902. They lived always in segregation, never saw a king, and on March 8, 1903, had laid nineteen eggs. Nine days later several of the eggs had hatched and two of the larvæ were well grown. There was no room for doubt that these eggs were parthogenetic, or that they were laid by a worker about six months old.

ung ants, like the adults, failed to discern any difference in contact-odor ie to diversity in the light rays encountered."

In order to ascertain whether exposure of the inert young to different ;ht-rays would result in different contact-odors at a later time, I ok amber pupæ, between April 12 and May 12, from the violet nests, d segregated them in a dark Petri cell, and I likewise segregated in other dark cell as many pupæ from the orange nest. From the olet nests I thus secured about twenty callows, all hatched between ril 23 and May 14, that had passed the egg, the larval, and most of the pupal stage exposed during all daylight hours to the rays at the per end of the spectrum and without exposure to the red or green ys. From the orange nest I likewise secured about twenty callows, hatched between April 17 and May 14, that had been exposed dur- g the same period to the rays at the lower end of the spectrum, thout exposure to blue, violet or ultra-violet rays. No callow had et an ant of other group than the one in which it was hatched. When e youngest callow was one month old, on June 13, 1903, I intro- ced several callows, one by one, from each cell into the other cell. l were amicably received and were straightway permitted to share the care of the inert young; and when I united all the occupants of e two cells they lived together harmoniously. *The exposure of the gs, the larvæ, or the pupæ to unlike light-rays does not produce unlike ntact-odors in the ants developing from the exposed eggs, larvæ or pupæ.* The results of these experiments shows that *the contact-odor of these ts is not affected by the light-rays from which the ant-nurses instinctively thdraw the young; nor is exposure to light a cause of such change in contact-odor as is coincident with age.*

A NEW JAPANESE PLEUROTOMARIA.

BY HENRY A. PILSBRY.

The Academy has received from Mr. Y. Hirase a specimen of Pleurotomaria from Kashiwajima, province of Tosa, Japan. The shell represents a new species, which may be thus defined:

Pleurotomaria hirasei n. sp. Pl. XXII, figs. 1, 2.

Shell resembling *P. beyrichi* in shape and general characters. The upper surface is copiously streaked with crimson on a white ground, orange-tinted in places; the base being white with a few faint wide, flexuous reddish streaks. Sculpture above of spiral, regularly beaded cords; 7 above, 5 below the slit fasciole on the whorls of the spire, the beads closely placed, corresponding to close and rather strong plicæ, or ripples, which are oblique above, vertical below the slit fasciole; the latter being sculptured with the usual arcuate striæ, and traversed by a wide median cord, with a thread below it. On the last whorl the beaded cords become more numerous, about 10 above the fasciole. The base is nearly flat, and has many spiral cords and threads, made crenulate by fine radial, flexuous folds. The slit is about one-fifth of a whorl long. The columella is twisted in a strong, convex lobe. The apical whorls are wanting in the type, and the lip is somewhat broken.

Alt. 72, diam. 81 mm.

The height would be 4 or 5 mm. greater in a perfect shell, the apical whorls of this one being broken off.

P. beyrichi as figured by von Martens, Dautzenberg, Schmalz and others, has much more widely spaced spiral cords, which are weakly beaded, in place of the closely beaded and more crowded cords of this species.

A COLLECTION OF FISHES FROM PARAGUAY, WITH A SYNOPSIS OF THE AMERICAN GENERA OF CICHLIDS.[1]

BY CARL H. EIGENMANN AND CLARENCE HAMILTON KENNEDY.

The Indiana University has received from Prof. J. Daniel Anisits, the National University of Paraguay, a large and well-preserved llection of fishes made during 1900 and 1901. The collection con- ıts of about 750 specimens and was made in the following localities:

1. Rio Paraguay and Laguna Pasito; and Rio Paraz at Asuncion.
2. Estancia La Armonia, Department Caapucu near the Laguna ıoá, the largest lake in Paraguay, and into which all the streams of e neighborhood empty. Collections were here made in the Arroyo ırumbey.
3. Laguna Ipacaray and its tributary Arcgua, twenty-four kilo- eters east of Asuncion. The laguna is about on a level with the io Paraguay and connected with it by the Arroyo Yuqueri.
4. Rio Paraguay at Fuerte Olympo.
5. Laguna at Pirayu Paraguay.
6. Campo Grande Lagunitas, five kilometers from Asuncion.
7. Rio Apa, forming the northern boundary of Paraguay, and its ibutaries Arroyo Pypucú, about one hundred and twenty kilometers om the Rio Paraguay.
8. Arroyo Trementina, a tributary of the Rio Aquido Canigi and quadas and Lagunitas along the Arroyo.
9. Arroyo Chagalalina, also a tributary of the Rio Aquido Canigi.
10. Toldocuc Estero, near Arroyo Chagalalina.
11. Salamanca, a landlocked laguna on a mountain near the Arroyo ypucú, and between Rio Apa and Rio Aquidaban.
12. Fazenda das Conchas, in a partially dried small laguna near io Branco, Matto Grosso, Brazil.

The collection contains also a series collected by Dr. Carl Ternetz ı the Paraguay at Asuncion and at Descalvados, Matto Grosso, Brazil.

In the present paper we give a list of all the specimens received, ith descriptions of new species. We have also prepared a synopsis f the genera of Cichlids.

[1] Contribution from the Zoological Department of Indiana University, No. 56.

Notes on the Species Received.[2]

1. Potamotrygon hystrix Müller and Henle. Raya, Yabelíri.

Eight specimens (No. 43). Laguna and Rio Paraguay, at Asuncion.

2. Bunocephalus rugosus sp. nov.

Type, No. 9,819, one specimen (No. 221). 40 mm. Laguna near Arroyo Chagalalina.

D. 5; A. 7; V. 6.

Body slender, greatest width in front of pectoral $2\frac{1}{3}$ in length. Head and body moderately deep; the greatest depth $7\frac{1}{2}$ in the length. The depth at the base of the dorsal spine $1\frac{1}{2}$ in the distance from the tip of the snout to the base of the pectoral spine.

The ridges and knobs of the head well developed. The skin over the snout and sides of the head very warty; the nuchal crest long and thin, extending $\frac{2}{3}$ the distance to the base of the dorsal. Just beyond its distal end is a small knob. On each side of the anterior end of the nuchal crest is a lateral crest. These lateral crests run $\frac{2}{3}$ the length of the nuchal crest, converging slightly. Further, on each side there are two prominent crests which pass obliquely downward and forward to the short, high, humeral crest.

The interorbital space very concave. The crests bounding it are the most prominent of any on the head. They arise just back of the anterior nares, and after enclosing an elliptical space end at the base of the nuchal crest. On each of these there are four prominent knobs, two just back of the eye, and two just in front of the nuchal crest. The eyes are placed laterally in these ridges.

The interorbital width equals the snout plus the eye.

The maxillary barbels reach to the middle of the pectorals. Mental barbels short, reaching $\frac{1}{3}$ the distance to the post mentals. Post mentals reaching to the anterior end of the gill cleft.

Coracoid processes parallel behind, their length $1\frac{2}{3}$ in the distance between them, the processes extending half-way to a perpendicular dropped from the base of the dorsal spine. The coracoid processes and ridges very similar to those of *B. bicolor*.

Humeral process extending about $\frac{1}{3}$ the length of the pectoral spine.

Pectoral pore small, round.

Skin everywhere covered with very conspicuous warts; those on the sides of the body and tail arranged in about 7 rows on each side.

[2] The numbers in parentheses are the ones used by Prof. Anisits to indicate the various lots he collected. The numbers of the types are those they bear in the register of the Indiana University. The common names are those collected by Prof. Anisits.

Distance of the dorsal from the tip of the snout $2\frac{2}{5}$ in the length. Pectoral spines twice as long as the coracoid processes, armed on both edges with long hooks, those on the posterior edge and on the proximal half of the anterior edge pointing inward, those on the distal half of the anterior edge pointing outward.

Color dark brown; the numerous warts white, giving a speckled appearance. The fins light brown, irregularly speckled and mottled with darker.

This species is most closely related to *B. gronovii* and *B. bicolor*. It agrees with *gronovii* in the distance of the dorsal spine from the tip of the snout and in having the keels and knobs of the head well developed. It differs from *gronovii* in having the coracoid processes only half as long.

It agrees with *bicolor* in having 7 anal rays, and in the general shape of the coracoid ridges and processes. It differs from *bicolor* in having the knobs and keels of the head better developed.

3. Rhamdia quelen (Quoy and Gaimard). Bagre or Mandii, Mandii guarú.

Four specimens (Nos. 25, 133, 148, 269). Estancia La Armonia; Asuncion and Campo Grande.

4. Pimelodus ornata Kner. Mandii guarú.

One specimen (No. 167). Laguna at Asuncion. Very rare. Prof. Anisits records taking another specimen in the Arroyo Trementina.

5. Pimelodus albicans (Cuv. and Val.). Mandii guarú.

Two specimens (Nos. 54 and 56). Rio Paraguay at Asuncion.

6. Pimelodus clarias (Bloch). Bagre amarillbo, Mandii saiyu.

Three specimens (Nos. 197 and 263) of type *b*, as defined by Eigenmann. Arroyo Trementina and Rio Paraguay at Asuncion.

Seven specimens (Nos. 149, 166, 551). Rio Paraguay at Asuncion. The most abundant of the fishes.

7. Pimelodus valenciennis (Kröyer). Bagre and Mandii.

One specimen (No. 259). 20 cm. Laguna Ypacarai (Aregua). Anal rays 15.

8. Iheriniohthys labrosus (Kröyer).

Nine specimens (Nos. 55, 150, 162, 163, 165). 10–19 cm. Asuncion, Rio Paraguay.

9. Hemisorubim platyrhynchos (Cuv. and Val.).

One specimen (No. 53). 42 cm. Asuncion, Rio Paraguay.

10. Pseudoplatystoma coruscans (Agassiz). Suruby.

Two specimens (No. 47). 40 and 48 cm. Asuncion, Rio Paraguay. This is a common market fish. It reaches a length of a meter.

11. Sorubim lima (Bloch and Schneider). Pico de pato = duck-bill.

One specimen (No. 48). 35 cm. Asuncion, Rio Paraguay. Rare

12. Doras costatus Linnæus.

One specimen (No. 130). 20 cm.

13. Doras maculatus Val. Armado and Ytagua.

One specimen (No. 51). 36 cm. Asuncion, Rio Paraguay. March, 1900.

A common market fish; meat of good flavor.

14. Doras nebulosus sp. nov.

Type, No. 9,837, one specimen (No. 129). 16 cm. Collected by Dr. Carl Ternetz, either in Matto Grosso or Asuncion.

Form elongate; depth below dorsal equals width. Caudal peduncle narrow, compressed, width 1⅓ in height. Humeral processes with a narrowed base, point acute. Dorsal plate roof-shaped, prolonged back of the first dorsal ray in a narrow process. Fontanel elongate, ending in front in a groove extending to between the posterior nares. Humeral processes and bones of the top of the head finely granular. Opercles, suborbitals and prenasals entirely covered with skin.

Eye small. 7½ in head, 3½ in snout, 2 in interorbital. Center of eye as far from posterior nostril as this is from anterior nostril, and as far as the anterior nostril is from tip of snout.

Maxillary barbel scarcely reaching the gill opening. Mental barbels twice as long as eye; post mental barbels slightly longer.

Snout narrow, width just back of maxillary barbels 4 in head. Mouth inferior, width 1½ in snout. A small band of intermaxillary teeth ⅓ as long as mouth is wide, the width of the band ⅓ in its length. Maxillary teeth in a triangular patch, slightly wider than the inter-maxillary band and half as deep as wide.

Gill membranes separate to below the bases of the pectoral spines. Breast entirely covered with skin.

Lateral plates narrow, the first 5–6 without dorso-ventral wings. The lateral plates widest beneath the adipose, where their width is contained in depth of body 3½ times. The median hooks the same height for the whole length.

A median series of 10–12 plates between the adipose and the caudal and a similar series of 10–12 between the anal and caudal.

Distance of the dorsal spine from tip of snout 2½–2⅔ in length of body. Dorsal spine about as long as the head, very strongly serrated on both edges; the spines on the posterior edge twice as long as those on the anterior edge. Distance of adipose from dorsal 4⅓ in the length. Adipose low, its base ⅔ longer than base of dorsal.

Anal fin rounded, its height 1⅔ in head.

Pectoral spine similar to dorsal, reaching the 5th or 6th scute.

Light brown, shading into lighter below, everywhere mottled and marbled with darker shades. The fins similarly colored.

Lat. plates 29–30; head $3\frac{3}{5}$; depth $4\frac{2}{3}$; D. I, 6; A. 13; V. 7; P. I, 8.

5. **Oxydoras knerii** (Bleeker). Armado, Ytagua-poschú.[3]

Two specimens (No. 52), 35 and 36 cm. Asuncion, Rio Paraguay (laguna). March, 1900. Very abundant; the commonest market fish.

One specimen (No. 131). Matto Grosso or Asuncion.

6. **Auchenipterus nigripinnis** Boulenger. Bagre.

One specimen (No. 71). 17 cm. Asuncion, Rio Paraguay (Pasito). Very rare.

7. **Trachycorystes striatulus** Steind.

One specimen (No. 61). 13 cm. Asuncion, Rio Paraguay. Taken alive from the stomach of a large Sorubim. It is not known to the fishermen.

8. **Loricaria rostrata** Spix.

Two specimens (Nos. 180 and 125), a male and a female. 300 and 20 mm. From the Arroyo Trementina and from a laguna near Asuncion, Rio Paraguay.

9. **Loricaria labialis** Boulenger. Maimingué.[4]

Eight specimens (Nos. 62, 151, 175, and 178). 130–240 mm. Asuncion, Rio Paraguay. Common, caught with seine. One specimen (No. 14), 130 mm., from Arroyo Trementina. Our specimens agree in nearly all respects with those described by Boulenger. The snout is slightly thicker and more acute. The labial fold is slightly fringed.

10. **Loricaria stübelli** Steindachner. Maimingué.

Thirteen specimens (Nos. 64, 177 and 179). From Asuncion, Rio Paraguay. Two specimens (Nos. 207 and 212), from the Arroyo Trementina. Nos 177 and 207 are males with broad under lip.

These specimens differ from Steindachner's figure of *stübelli* in the greater width of the interorbital, $3\frac{3}{5}$ in length of head.

11. **Loriacaria lata** E. and E. Maimingué.

Nine specimens (Nos. 60, 163, 142, 175, and 210). 70–280 mm. Asuncion, Rio Paraguay. One specimen (No. 210) from Arroyo Trementina.

12. **Loricaria lamina** Günther.

One specimen (No. 124). 200 mm. Matto Grosso. Collected by Dr. Carl Ternetz.

[3] Yta = stone, gúa = place, poschu = bad.

[4] Maimi = old woman, gué = it was.

23. Hypoptopomus thoracatum Günther.

One specimen (No. 126). 80 mm. Matto Grosso. Collected by Dr. Carl Ternetz.

24. Plecostomus commersoni (Val.).

Two specimens (No. 113). 170 and 220 mm. Matto Grosso. Collected by Dr. Carl Ternetz.

25. Plecostomus vermicularis Eigenm. and Eigenm.

One specimen (No. 213). 70 mm. Arroyo Trementina. Caught in a fish trap.

26. Plecostomus boulengeri sp. nov.

Type No. 9,868, one specimen (No. 112). 10 cm. Co-type No. 9,869, one specimen (No. 112). 6 cm. Both specimens from Matto Grosso or Asuncion. Collected by Dr. Carl Ternetz.

Head pointed; a low ridge from between the nares to the snout; three distinct ridges on the back part of the head. Occipital process short, triangular, bordered by a single nuchal plate. The nuchal plates bicarinate. Only the upper lateral plates on the anterior part of the body keeled. The humeral ridges moderate, extending over the first 4–5 plates. Tip of the snout naked. Belly covered with small granular plates, except for a small area in front of each ventral. In the younger specimen the belly is entirely naked.

Eye 2–2½ in interorbital, 2½–3 in snout, 4–4½ in head. Eye larger in the younger specimen, 2½ in snout, 4½–4¾ in the head, 2 in the interorbital.

Base of dorsal fin equals distance from dorsal to posterior end of adipose dorsal. First dorsal ray 1½ in the distance from dorsal to tip of snout, slightly longer than head. Last dorsal ray 1½–1¾ in first dorsal ray.

Caudal obliquely truncate; outer rays not produced.

Head and body covered with small round spots; those on the head minute; those on the belly large, leaving a mere reticulation of the lighter ground color. The fins reddish, the dorsal with four rows of large round spots; in each row a single spot on each interradial membrane. In the larger specimen the two upper rows are indistinct; in the younger specimen all the dorsal spots are indistinct. Caudal with four oblique bands. The pectorals and ventrals each with four dark bands. Anal dusky with a single band.

Lat. plates 26; head 4½; depth 5; D. I, 7; V. 5; A. 5; P. I, 6.

This species is evidently related to *commersoni*, *scabriceps* and *plecostomus*. It agrees with the latter in the number of lateral scutes.

It is distinguished by the oblique dark bar on the caudal, less distinct than the rows of spots on the dorsal which toward the tip of the fin are also partially resolved into bars.

27. Cochliodon cochliodon (Kner).

Two specimens (No. 211). 230 and 300 mm. Arroyo Trementina. Caught in a fish trap. One specimen (No. 111). Matto Grosso?

28. Pterygophlichthys anisitsi sp. nov. Maimingué.

Type No. 9,873. 42 cm. (46.) Co-types 9,874 and 9,875. Two specimens (No. 46). 40–42 cm. Called La Vieja in Spanish and Maimingué by the natives. Laguna of the Rio Paraguay at Asuncion. Caught with seine; very abundant.

Form slender; depth under dorsal $1\frac{1}{3}$ in the width. Caudal peduncle slightly compressed. Head depressed, length $1\frac{1}{3}$ in width, depth $1\frac{1}{3}$ in length. An occipital ridge. Occipital process narrow, the sides almost parallel, bordered by three nuchal plates. All dorsal and lateral scutes carinate, each carina with short spines. Tip of snout granular. Thorax and abdomen entirely granulose.

Eye $4\frac{1}{3}$–5 in snout, 4–$4\frac{1}{2}$ in interorbital, 6–7 in head. Preopercle erectile.

Base of dorsal longer than distance from dorsal to base of caudal. Distance from the dorsal to the adipose contained in the length of the dorsal $1\frac{3}{4}$–$2\frac{1}{4}$ times. Distance of dorsal spines from snout $2\frac{1}{2}$ times in length, the spine once in the head. The tips of the last dorsal rays reach slightly more than $\frac{1}{2}$ distance to adipose spine.

Adipose spine hooked, compressed, covered with short spines, especially the curved end.

Caudal oblique, not emarginate; outer rays heavy, the dorsal one somewhat compressed, not produced beyond the other caudal rays. Height of anal $1\frac{1}{3}$ in head. Ventrals equal length of head. Pectoral spine reaching half the length of the ventrals.

Body dark, almost black, covered on the sides and belly with lighter vermiculations. Passing caudad the vermiculations of the sides are gradually replaced by spots. Back of the dorsal one spot on each plate, so that the caudal peduncle has several longitudinal rows of moderately large spots. The head with the same dark ground color both above and below, uniformly covered with small light-colored spots, those on the posterior part of the head larger and gradually passing into the vermiculations of the sides.

The interradial membrane of the dorsal, caudal, ventrals and pectorals dark, obscurely spotted, but in the darker individuals entirely black. Anal membrane dusky with obscure spots. The rays of all

the fins light with dark spots. Head 4–4½; D. I, 11; A. 5; Lat. l., 29–30.

29. Pterygophlichthys juvens sp. nov. Maimingué.

Type No. 9,876, one specimen (No. 92). 4 cm. Caught with seine at Asuncion, Rio Paraguay, April, 1900.

Form slender, depth under dorsal 1½ in width. Caudal peduncle compressed.

Head moderately elevated, its length slightly greater than its width. Two occipital ridges. Nuchal plates rudimentary. Occipital process broad and triangular. Preopercle erectile; 8–12 teeth on each side in each jaw.

Eye 2⅓ in snout, 2 in interorbital, 4 in head.

Snout and suborbital regions naked. Under side of head, breast and belly naked. Dorsal and lateral scutes carinate.

Base of dorsal equals distance from dorsal to base of caudal. Distance of dorsal spine from tip of snout contained in the length 2⅓ times. No adipose. Caudal oblique, not emarginate, ¼ of total length. Height of anal 1½ in head. Ventrals equal in length to head, reaching base of anal. Pectoral spine reaching base of ventrals.

Color uniform black, except breast and belly which are silvery. All the fins with alternating light and dark crossbars. Dorsal with 6 horizontal bands alternately transparent and black, the base transparent, the top black. Anal with four similar bars similarly arranged. Caudal with 7–9 alternating bars, the light ones less distinct.

Lateral plates 27; head 3⅗; D. I, 12.

This species may be the young form of the three adult specimens (*Pterygophlichthys anisitsi*) caught at Asuncion; but no trace of adipose dorsal could be detected.

30. Ancistrus cirrhosus dubius Eigenm. and Eigenm.

One specimen. 55 mm. The specimen is so badly mutilated that the identification is doubtful.

31. Callichthys callichthys hæmaphractus (Hensel).

One specimen (No. 265), young. 5 cm. Campo Grande.

32. Haplosternum pectoralis (Boulenger).

Four specimens (No. 101). 7–9 cm. Rio Branco, Matto Grosso.

33. Haplosternum littorale (Hancock).

Two specimens (Nos. 23 and 24). 18 and 19 cm. Arroyo Carumbey and Yajamar, Estancia La Armonia.

These specimens fit the description of *littorale* in the "Nematognathi of South America" by E. and E. Two other specimens (No. 155)

rom a small lagoon in Campo Grande, 5 kilos from Asuncion and he Rio Paraguay, differ from the first two in having the posterior margins of the anterior pair of nuchal plates very much rounded. In fact, ie posterior border on either side lies for ¾ its length at right angles o the axis of the body. They differ also in being of a uniform dull ad color and in the size of the eye—6½ in the interorbital. The two pecimens differ as follows:

Specimen *a*, 21 cm. (♂?). Pectoral spines as long as head. In this pecimen, which is probably a male, the skin along the under side of ie pectoral rays is greatly thickened, forming along each ray for ¾ its ngth a heavy ridge.

Specimen *b*, 18 cm. (♀?). Pectoral spines 1¾ in head.

KEY TO THE SPECIES OF CORYDORAS.

a. Coracoid processes meeting on median line of anterior portion of belly at least.

b. A dark brown lateral band extending from the occiput backward on the upper half of the body; ventral surface and a broad vertical band behind the eye light; caudal without bars, . *eques*.

b. Greenish, fins and top of head brown; a dark brown band on caudal. D. I, 9; Lat. pl. $\frac{24}{23}$, ... *splendens*.

a. Coracoid processes nowhere meeting; breast and belly with a median naked area.

c. Caudal plain.

d. Body with one or more dusky longitudinal bands; dorsal fin usually spotted.

e. Coracoid processes moderately expanded, leaving only a narrow naked area between them; occipital process triangular, pointed at the tip; a dark band extending from the upper caudal lobe forward, one or more longitudinal series of dark spots along the sides, ... *elegans*.

e. Coracoid process scacely encroaching on breast or belly. A blackish lateral band extending from the middle caudal rays forward.

f. Eye 2–2¼ in snout, 4–5 in head, 2–2½ in interorbital. First 4–5 dorsal rays as long as the dorsal spine, ... *microps*.

f. Eye 1½ in snout, 4 in head, 2 in the interorbital. First 2 dorsal rays as long as the dorsal spine, ... *nattereri*.

d. Body without longitudinal bands; dorsal plain. D. I, 7; A. I, 6; P. I, 7–8; V. 6.

g. Head and dorsal plates deep bronze; ventral plates yellowish; all the fins immaculate; opercle, humeral and nuchal plates iridescent blue; base of the dorsal fin shorter than the distance between the dorsal and adipose; depth less than ⅓ of total length; eye 4½ in head, more than 2 in the interorbital (Gill), ... *æneus*.

gg. Olive, the 9 or 10 anterior scutes with vertical series of blackish spots; base of the dorsal fin equal to the space between the dorsal and adipose fins; depth 3½ in the total length; eye about 3 in the head; spines of the fins very strong and long, dorsal spine as high as the body, pectoral spine shorter; 4–5 azygos shields (Günther), ... *armatus*.

cc. Caudal fin with 4–5 dark vertical bars; dorsal with dark markings.

h. Dorsal fin with 2 irregular crossbars; sides of body with series of dark blotches; middle of the lower fins blackish, . . *paleatus*.

hh. A dark vertical bar on the first dorsal rays, sometimes extending on to the body below; anal fin barred or spotted; ventrals and pectorals plain, ... *punctatus*.

hhh. Dorsal fin with 5 longitudinal rows of dark spots; 6 narrow bars on caudal. Top of head tinged with brown; a yellowish band across snout, otherwise the fish without color, . *aurofrenatus*.

hhhh. Dorsal with black spot on ends of rays.

i. Anal spotted; dark brown above, 3 series of dark spots along middle of side, ... *trilineatus*.

ii. Anal plain.

j. Lat. plates $\frac{22}{21}$; azygos plates none; a pale band on side; clavicle and opercle with blue reflections (Cope), ... *acutus*.

jj. Lat. plates $\frac{21}{19}$; azygos plates 4; numerous dark dots on the sides; shields which are wanting on middle line of side; a black spot at the base of the dorsal spine (Cope), ... *amphibelus*.

ccc. A hastate black spot at base of caudal fin, margined behind by white; a black lateral band, ... *hastatus*.

34. Corydoras microps sp. nov.

Type No. 9,892, one specimen (No. 100). From a small lagoon, half dry, near the Rio Branco (Matto Grosso, Brazil), where there were thousands of these fishes. Co-types No. 9,893, three specimens (260). From Aregua, in a brook which empties into the Laguna Ypacarai. Sides metallic green. June, 1901. Co-types No. 9,894, one specimen (No. 236). Aguadas, near the Arroyo Trementina. December, 1900. Co-types No. 9,895, two specimens (No. 215). 1½ cm. From Arroyo Pypucú. January, 1901.

Short, deep, ventral outline almost straight to base of anal. Profile steep to nostrils, less steep and evenly rounded from nares to dorsal.

Eye 2–2¼ in snout, 4½–5 in head, 2⅓–2½ in interorbital.

Mouth inferior, snout conical; maxillary barbels scarcely reaching gill-openings, labial barbels slightly longer. Fontanel elongate, narrow, extending into the base of the occipital.

Coracoid processes narrow. The distance between them equals ½ distance between bases of pectoral spines.

Three to four azygos plates before the adipose fin.

Distance of dorsal spine from tip of snout 2 in length; the spine $1\frac{3}{4}$ in head; roughened behind; first 4–5 rays higher than the spine.

Pectoral spine $1\frac{1}{3}$–$1\frac{2}{3}$ in head, outer side smooth, inner roughened.

Caudal deeply forked, $2\frac{1}{2}$–3 in length, its dorsal lobe slightly longer.

Color yellowish-brown changing to white below; a light middorsal band, extending from fontanel to base of caudal. At the base of the dorsal this band widens into a dark spot. A lateral band starts at the base of the caudal and widens as it passes forward, to end in a more or less distinct lateral spot. All the fins are plain.

Three of the specimens (260) are darker. The lateral band is not distinct from the middorsal. The top and sides of the head, the dorsal and caudal fins are tinged with dark.

Lat. plates $\frac{22-23}{20}$; D. I, 7–8; A. 7–8; V. 6; P. I, 8–9.

These specimens, measuring between 15–60 mm., differ from the adult in having the eye $1\frac{1}{2}$ in the snout, 3 in the head, and $1\frac{1}{3}$ in the interorbital. Depth $2\frac{1}{2}$, head $2\frac{2}{3}$, dorsal spine $1\frac{2}{5}$ in head, pectoral spine $1\frac{1}{5}$ in head.

This species stands nearest to *nattereri*, from which it differs in having the eye smaller, snout more conical and in the shape of the dorsal fin.

15. Corydoras aurofrenatus sp. nov.

Type No. 9,891, one specimen (235). 55 mm. Aguada, near Arroyo Trementina. December, 1900.

Body elongate, fins and head small. Profile obtusely angled between the nares, steep from the nares to the snout. Fontanel very elongate, extending to the base of the occipital process. Width of occipital $1\frac{1}{4}$ in its length.

Eye 2 in snout, $1\frac{1}{4}$ in interorbital, $3\frac{1}{2}$ in head.

Snout conical, somewhat compressed. Posterior margin of opercle slanting downward and forward. Distance from upper end of gill-opening to eye equal to diameter of eye. Labial barbel reaches gill-opening; maxillary barbel slightly shorter. Mental barbels equidistant from each other and the angles of the mouth.

Coracoid process scarcely encroaching on the breast or belly.

Three to four azygos plates before the adipose.

Distance of dorsal spine $2\frac{1}{6}$ in length; its height $1\frac{1}{3}$ in length of head. First two dorsal rays exceed the spine. A band of spines, similar to those on the plates, along the anterior edge of the spine. A similar band but narrower on each lateral edge of the spine; the posterior edge roughened. Caudal forked for half its length; about $2\frac{3}{4}$ in the length.

Pectoral spine similar to dorsal in length, a similar spinous ban[illegible]and along its upper anterior edge, posterior edge serrated.

No color on sides, belly or breast. Top of head slightly tinged wit[illegible]ith brown. A broad yellow band across the snout. Dorsal colorles[illegible]es except for dark spots on the rays, arranged in 5 longitudinal rows. [illegible] vestige of a sixth row on the tips of the first and second rays. The [illegible] rays of the caudal similarly spotted, the spots arranged in about [illegible]t vertical rows, giving the appearance of 6 narrow bars. The adipose [illegible] anal, ventrals and pectorals plain.

Head 4 in body; depth 3; D. I, 7; A. 7; V. 6; P. I, 9. Lateral [illegible] plates $\frac{22}{10}$.

This species stands nearest to *punctatus* and *trilineatus*. From both [illegible] it differs mainly in coloration.

36. Hoplias malabaricus (Bloch). Tarcui.

Thirteen specimens (31, 58, 107, 154, 196, 231). Estancia La Ar-[illegible] monia; Arroyo Carumbey; Asuncion; Rio Branco, Matto Grosso[illegible]s Arroyo Trementina; Arroyo Chagalalina.

37. Hoplerythrinus unitæniatus Spix. Tarcui.

Four specimens (57, 98, 99, 239). Estancia La Armonia; Ri[illegible] R Branco, Matto Grosso.

38. Pyrrhulina australe sp. nov.

Pyrrhulina semifasciata Boulenger. Trans. Zool. Soc. London, XIV, par[illegible]pa II, 1896 (not of Steindachner).

Type No. 9,901 (254), 50 mm. Arroyo Trementina.

Co-types No. 9,901, 21 specimens (254). 30–50 mm. Arroyo Tre[illegible] mentina.

Co-types No. 9,900, 13 specimens (227). 33–48 mm. Arroyo Chaga[illegible] lalina, Laguna.

This species is evidently closely related to *P. semifasciatus*, fro[illegible]on which it differs largely in coloration. A conspicuous jet-black band[illegible]nd, much narrower than the pupil, extends forward from the eye aroun[illegible]and the tip of the lower jaw. In these specimens preserved in formalin it [illegible]t is not possible to say whether the band extends through the eye. N[illegible] No distinct streak behind the eye on upper part of opercle. No spots [illegible] or streaks on the body.

Head 4; depth 4–4½; Lat. l., 20–23; D. 8–10; A. 10 or 11.

Teeth of the dentary slightly larger at their lateral ends.

Four specimens from Estancia La Armonia, Arroyo Carumbey m[illegible]ay be referred to this species. They differ in coloration. The ba[illegible]nd around the snout is continued back through the eye, where it is cons[illegible]d-

erably wider than in front of the eye, and along the upper part of the cheek and opercle, where it is still wider and much less intensely black, merging into the color of the body and top of head. Body unspotted, dark above, lighter below.

39. Psectrogaster curviventris sp. nov. Blanquillo.

Type No. 9,919, 180 mm. (36). Asuncion, Rio Paraguay.

Co-type No. 9,918, 195 mm. (36). Asuncion, Rio Paraguay.

Co-type No. 9,920, 183 mm. (83). Asuncion, Rio Paraguay.

Co-types No. 9,921, 3 specimens, 107–122 mm. (34). Asuncion, Rio Paraguay.

Co-types Nos. 9,936–9,937, 2 specimens, 145 and 160 mm. (145, 234). Fuerte Olympo, Rio Paraguay.

This species is closely related to *Psectrogaster rhomboides*, from which it differs in a number of characters, notably the ventral outline, the number of fin rays and scales.

Head $3\frac{1}{2}$–$3\frac{1}{4}$ ($3\frac{1}{6}$ in smallest specimen); depth 2–$2\frac{2}{9}$ ($2\frac{1}{4}+2\frac{3}{5}$ in *rhomboides*); D. 10 or 11 (12 or 13 in *rhomboides*); A. 9 or 10 (10 or 11 in *rhomboides*); Lat. l., 48–52 (53–58).

Compressed and deep, the depth usually 2 in the length, rarely less, $2\frac{2}{5}$ in No. 9,937. Ventral outline regularly arched, without an angle at the origin of the ventral; dorsal outline less regularly arched, the base of the dorsal oblique; the region between dorsal and nape strongly arched, top of head depressed.

A narrow adipose lid in front and behind. Eye $3\frac{1}{5}$–$3\frac{1}{2}$, equal to the snout and anterior adipose lid, 2 in interorbital.

Scales on back small, becoming larger on the sides and largest on breast. Scales all ctenoid, becoming pectinate on breast.

Air bladder extending little, if any, beyond origin of anal.

Origin of dorsal as in *rhomboides*, equidistant from tip of snout and upper caudal fulcra or a little nearer caudal; the highest ray about equal to the length of the head or shorter. Caudal broad and deeply notched. The middle rays only $\frac{1}{3}$ the length of the longest outer rays, outer rays leathery. Anal short, emarginate, the tip of the longest ray reaching tip of the last. Pectorals not reaching ventrals except in 9,937; ventrals about $\frac{2}{3}$ to vent.

Plumbeous above, bright silvery below, indications of bright stripes along the rows of scales above the lateral line and between the rows below the lateral line. In 9,936 and 9,937 (preserved in formalin) there is no metallic silvery and there is a dark band along the posterior half of the lateral line, increasing in width and intensity toward the tail. No. 9,937 evidently in shape and color approaches *rhomboides* most closely.

40. Curimatella alburnus australe var. nov. Blanquillo.

Type 9,929, one specimen (65). Asuncion.

A single specimen differs from the typical northern *alburnus* in having the predorsal region trenchant with a strong median and indistinct lateral keels, and in having 33 scales in the lateral line instead of 36–38. It approaches var. *lineatus* in the number of scales, but has no middorsal line.

41. Curimatus gillii sp. nov.

Type No. 9,939, 47 mm., Arroyo Trementina (242).

Co-type No. 9,938, 57 mm., Chagalalina (230).

These two small specimens represent apparently a new species related to *C. spilurus*. It certainly differs from *C. nasus* and *bimaculatus* the only other species of *Curimatus* that have been taken in the Arroyo Trementina.

Caudal lobes naked; postventral region rounded; sides in formalin specimens with an obscure lateral band terminating in a large, well-marked spot on the end of the caudal peduncle.[5] Dorsal plain.

Head $3\frac{1}{3}$; depth $2\frac{3}{4}$; Lat. line 30 or 31; D. 10 or 11; A. 9.

Long elliptical, dorsal and ventral profiles equally arched. Preventral region flattened, with a median series of large scales; postventral region rounded. Predorsal region narrow, rounded, a triangular groove over the occipital process.

Scales of the sides all crenulate.

Profile gently arched; eye 3 in head, $1\frac{1}{5}$ in interorbital. Origin of dorsal midway between tip of snout and base of caudal in the type and between tip of snout and tip of adipose in the co-type. Origin of ventrals nearer caudal than tip of snout. Pectorals not to ventrals; ventrals to anus.

For Dr. Theodore Gill, in recognition of his valuable contributions to the knowledge of the Characinoids.

42. Curimatus nasus Steindachner.

Two specimens from Arroyo Trementina (186), preserved in formalin, have a plumbeous lateral band about as wide as the eye.

43. Curimatus elegans paraguayensis var. nov. Mojarra.

Type No. 9,928, one specimen (18 in part), 135 mm. Estancia la Armonia, Arroyo Carumbey.

Co-type No. 9,954, one specimen (87), 100 mm. Asuncion, Rio Paraguay.

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[5] The pigment cells of the lateral band are deeper in position than those forming the caudal spot and would probably not be apparent in specimens preserved in alcohol. Certainly other specimens preserved in alcohol show no band, while specimens in formalin show a band.

This variety differs from *bahiensis* in the number of its scales. Depth the type $2\frac{3}{5}$, scales 38; in the co-type $2\frac{1}{5}$, scales 39.

. **Curimatus bimaculatus** Steindachner. Blanquillo.

This species, heretofore known from the Amazonas, is represented · typical specimens from Estancia La Armonia (18 in part); Arroyo ementina (189); Rio Paraguay at Asuncion (65, 140, 170). Speci- ɔns preserved in formalin have a broad, dark lateral band and a con- icuous dark spot in front of the dorsal.

Curimatus gilberti Quoy and Gaimard.

Two specimens from Estancia la Armonia.

Anodus latior (Spix). Blanquillo.

Three specimens (35 and 97), from Rio Paraguay at Asuncion and ıerte Olympo.

Prochilodus scrofa Steind. Zabalo; Carimbata.

Six specimens, Asuncion, Rio Paraguay (Nos. 40, 81, 174); Estancia ı Armonia (19); Arroyo Trementina (205); one specimen received ɔm Dr. von Ihering from Piricicaba.

ı. **Hemiodus orthonops** sp nov.

Type No. 9,955 (202), Arroyo Trementina, 150 mm.

Co-types Nos. 9,956–9,960 (171, 50, 4, 77), five specimens, 170–225 ım. Laguna of Rio Paraguay at Asuncion.

A slender, small-scaled species. Dorsal profile from tip of snout to rigin of dorsal slightly but evenly arched. Ventral profile from tip ፡ snout to insertion of ventrals of a like even curvature. Dorsal pro- le from origin of dorsal to caudal peduncle nearly straight. Ventral rofile from insertion of ventral to origin of anal slightly convex, rising ɔruptly from origin of anal to caudal peduncle. Depth of caudal ɔduncle $2\frac{2}{3}$ in head.

Head subconical, flattened above and on the sides. The lower side the mandible flattened. Mouth in the ventral profile. The rami the mandible approaching each other posteriorly. Maxillary short, ırtly sheathed under the broad preorbital. Mandible toothless. remaxillary with a single series of about 24 movable, short, flat, ser- ted teeth.

Eye large, $3\frac{1}{2}$ in head, 1 in snout, covered, with the exception of a ort slit over the pupil, by broad adipose lids.

Suborbitals covering cheek, with exception of a narrow space just ɔove the horizontal branch of the preopercle. Branchiostegal rays 4, ıt and overlapping each other. Opercle semicircular. Subopercle

Much compressed, back conspicuously elevated, the anterior profile aight, the upper profile strongly arched, descending backward from front of dorsal. Eye greater than snout, about 3 in head, slightly s than interorbital. Intermaxillary with six teeth in each side, each :h an inconspicuous median cusp and 3 to 4 graduated lateral cusps; : cusps of the teeth becoming more nearly of the same size and the ›th rounded toward the side. Maxillary with 2 seven- to eight-inted broad-tipped teeth. Mandible with 4 broad, seven-pointed :th; the middle point is largest, the tip spatulate. A few small :th on the sides of the lower jaw.

Origin of dorsal over origin of ventrals, slightly nearer tip of snout an base of caudal, its highest ray about equal to the length of e head. Caudal lobes longer than head. Pectorals reaching ven-als; ventrals not to anal.

In alcohol: Lower half of body metallic-silvery, a silvery lateral band. conspicuous caudal spot continued on the base of the middle caudal ys; a dark band at base of caudal. A dusky band on middle of ıck behind anal. Dorsal without dark spot, its first membrane dark; :her fins immaculate. In the co-types the anal reaches 22, the scales 4 or 35, head $3\frac{4}{5}$–$4\frac{1}{5}$. Eye $2\frac{3}{5}$.

6. Odontostilbe trementina sp. nov.

Type No. 9,987*a* (251 in part), 47 mm. Arroyo Trementina.

Co-types No. 9,987, 9 specimens (251 in part). Arroyo Trementina.

One other specimen was taken at Asuncion, and two others from a brook near the Arroyo Trementina.

This species resembles *H. peguira* in the color of the dorsal, but beyond this there is no similarity.

Depth 3; head 4; D. 11; A. 21; scales 6–34–4.

Two broad-tipped teeth on the maxillary, each with about 7 points. Intermaxillary with 6 spear-tipped teeth on each side, each with a large long median point and two or three short, graduated lateral points. Lower jaw with about 9 three- to six-pointed teeth on the sides, the first one large, the others small and decreasing in size backward; about 6 broad teeth on the dentary, each with 3 lobes of equal size, each lobe being indistinctly three-pointed. They appear as 3 distinct teeth. Maxillary reaching beyond anterior margin of eye.

Dorsal equidistant from tip of snout and base of middle caudal rays, behind the ventrals. Pectorals not to ventrals, ventrals not to anal.

In formalin: A conspicuous hastate caudal spot, extending forward as a faint dark line to below the dorsal where it fades out. A dark

area over the caudal spot. Anterior dorsal rays with a black spot near their tip. A yellowish humeral spot.

The anal in the co-types reaches 24 rays; Lat. l., 34–37; depth $2\frac{3}{5}$–3.

The specimens from the brook (255 in part) are very slender, depth $3\frac{1}{4}$ and $3\frac{3}{8}$ in the length. The dark markings are intense. The first developed dorsal ray of one is prolonged in a filament which reaches the adipose.

57. Cheirodon interruptus (Jenyns).

a. Ten specimens (No. 266), 28–42 mm., from Campo Grande, June, 1901, show the following characters:

	Min.	Max.	Average.
Length in mm.	25.0	42.0	31.6
Anal rays	22.0	27.0	
Depth	2.5	2.8	
Head	3.6	4.0	
Eye	2.6	3.0	
Teeth in maxillary	0	1	
Perforated scales	6	8	6.56

Scales 5.5 to 6–31 to 32–4 to 5.

b. Thirteen specimens (part of No. 251), 25–40 mm., from a brook near Arroyo Trementina show the following characters:

	Min.	Max.	Average.
Length in mm.	18.5	34.0	27.81
Anal rays	21	23	
Depth	2.4	3.2	
Head	3.0	4.2	
Eye	2.2	3	
Teeth in maxillary	0	0	
Perforated scales	5	11	

Scales 5 to 7–30 to 36–$4\frac{1}{2}$ to 6.

The specimens mentioned above, compared with the description of *interruptus*, give the following results:

Specimens.	*Descriptions.*
Anal 20–27.	Anal 19–20.
Scales 30–36$\frac{5-7}{4-6}$.	Scales 35$\frac{5}{4}$.
Depth $2\frac{2}{5}$–$3\frac{1}{10}$.	Depth $2\frac{1}{2}$.
Head 3–$4\frac{1}{5}$.	Head 4.
Dorsal 10–11.	Dorsal 11.
Pectorals fall short of, reach to or slightly overlap ventrals.	Pectorals extend beyond root of ventrals.
A large, black caudal spot.	A black spot at the base of the caudal.
A dusky band from tail to below dorsal.	Sides with a bright longitudinal band.

don annæ McAtee sp. nov.

No. 4,301*a*, 43 mm. South America.

es No. 4,301 (14 specimens). South America.

pecies bears considerable resemblance to *pisciculus*, from which e distinguished by the absence of more than one maxillary he head 3–4 instead of 5, and the dorsal 9–12 instead of 10.

3⅝; head 4⅛; D. 11; A. 15; scales 7–32–5. Four five-pointed each side of the intermaxillary, the median points longest. y with a single four-pointed tooth, but little smaller than the intermaxillary. In the lower jaw there are six four-teeth on each side, largest in the middle and grading to quite es at the sides.

of the dorsal nearer the base of the caudal than tip of snout. s not to ventrals; ventrals not to anals. Coloration (in alco-k olive; belly light golden; a silvery band from base of caudal of opercle margined above by blackish. Sides of head silvery. o-types show considerable variation. Some have 5 teeth on e of intermaxillary and lower jaw. Two have no teeth in the ies. Other variations as follows:

l 9–12; anal 12–15; scales 6 or 7–32 to 36–5 or 6; depth 4⅛ d 4⅛–3⅝; eye in head 3⅛–2⅛.

s of specimens:

	Min.	Max.	Average.
n mm	29.0	43.0	37.2
	9.0	12.0	
	12.0	15.0	
	3.4	4.2	
	3.4	4.2	
	2.8	3.2	
maxillary	1	1	
ed scales	7	9	

to 7–32 to 36–5 to 6.

above description is by one of my students, Mr. Waldo Lee who dedicates the species to his mother.—C. H. E.)

don insignis Steindachner.

odon insignis Steindachner, Fisch-Fauna des Cauca und Flusse bei ayaquil, 22, Pl. VI, fig. 3, 1880 (Cauca.).
odon insignis Ulrey, Ann. N. Y. Acad. Sci., VIII, 291 (Para, Brazil).

nber of specimens of this species are in the collection. They ostly confounded with *Hemigrammus luetkeni*. In all the ns the caudal spot is large and sharply defined, not extending ip of the rays. It is bordered in front by an area of greater or

less extent which is entirely free from pigment, and behind by two yellowish spots. Three specimens (part of 253) are light straw color with a yellowish fatty humeral area; a faint dark line along the middle of the sides. In two of these the spines of the lower caudal are nearly typical, in the third they are weak. Arroyo Trementina.

Seven specimens (part of 219) are notably darker; in only one of these is the serration of the caudal spines typical. Young with a black lateral band. Arroyo Pypucú.

Nine specimens (257), slender, elongate, quite dark, three of them with the typical caudal serrature, the others with the caudal rays not spine-like. Arroyo Pypucú.

60. Aphyocarax dentatus sp. nov. Piki.

Type No. 10,030 (part of No. 6), 71 mm. Asuncion, Rio Paraguay (Laguna). November, 1899.

Co-types, four specimens, No. 10,038 (part of No. 6), 53–71 mm. Asuncion. One specimen, No. 10,033 (96), 70 mm. Asuncion. April, 1900. Six specimens, No. 10,030 and 10,031 (237 and 247), 33–60 mm. From Aguadas, near Arroyo Trementina. December, 1900. Four specimens, No. 10,036 (8), 65–80 mm. Asuncion, Rio Paraguay (Laguna). November 1899. Piki. One specimen, No. 10,037 (found with 90). From Asuncion, Rio Paraguay. April, 1900. Taken with a seine.

This species differs from *pusillus* and *alburnus* chiefly in the length of the snout and the maxillary and in the number of teeth in the mandible.

Elongate, ventral profile slightly more curved than the dorsal. Dorsal profile but slightly convex from the tip of the snout to the origin of the dorsal, from origin of dorsal to base of caudal straight.

Head small, 4 in length, its depth $1\frac{2}{5}$ in its length. The teeth in a single series above and below. Maxillary teeth largely concealed, covering over half the anterior edge in the young; less in the old on account of the great elongation of the maxillary. Maxillary short in young, increasing rapidly in length with age, scarcely reaching beyond origin of eye in young, to end of pupil in the old.

Mouth small, very oblique in young, large and horizontal in adult, the jaws equal. Second and third suborbital bones large, entirely covering the cheek. The opercle triangular, its width $1\frac{4}{5}$ in its depth.

The eye small, 1 in snout, 4 in the head, $1\frac{1}{3}$ in the interorbital.

The dorsal small, its height $1\frac{1}{4}$ in the length of the head. Its last ray $2\frac{1}{3}$ in its height. Depth of caudal peduncle little less than half the length of the head.

The caudal small, deeply divided, its lobes equal to the length of :he head.

Pectorals reaching $\frac{2}{3}$ distance to ventrals. Ventrals reaching $\frac{3}{5}$ distance to origin of anal.

Height of anterior rays of anal equal to length of ventrals, the last ıalf of the anal but half as high.

Color in alcohol, straw. A faint silvery band extending from base ıf caudal to below the dorsal fin. The lower lip black. The fins immaculate. A note of the collector with No. 237 states that the caudal n is red.

Some of the examples preserved in formalin show the dorsal and pecorals edged with black in front. In a number of specimens the middle audal rays are dusky.

	Min.	Max.	Average.
ength in mm	33.0	79.0	55.7
nal	18.0	22.0	
epth	3.4	4.0	
lead	3.8	4.0	
ye	3.5	4.0	
erforated scales	7	14	
'eeth: Intermaxillary	14	20	
'eeth: Maxillary	9	13	
'eeth: Mandibular	36	42	

cales 5.5 to 7–36 to 39–4.5 to 6.

1. Aphyocarax alburnus?

A single specimen agreeing in many respects with *alburnus*, of which ve have not the original description. Length 31 mm. A. 19. Scales $\frac{1}{2}$–36–4$\frac{1}{2}$; depth 3; head 3$\frac{3}{4}$; eye 2$\frac{2}{3}$ in the head, 8 scales perforated; 4 intermaxillary, 2 maxillary and 18 mandibular teeth. Mouth very minute, snout little more than half the eye.

The specimen is deeper than in descriptions of *alburnus*.

2. Aphyocharax anisitsi sp. nov.

Type No. 10,028, 41 mm. (part of 8). Asuncion.

Co-types No. 10,027, one specimen (No. 6). Asuncion.

No. 10,029, three specimens (No. 7). Asuncion.

No. 10,024, nine specimens (160). Campo Grande.

No. 10,026, six specimens (264). Campo Grande.

No. 10,031, one specimen (94). Arroyo Trementina.

No. 10,025, one specimen (226). Arroyo Chagalalina.

This species is very closely related to *alburnus* from the Peruvian Amazons. It differs from that species chiefly in the number of scales in the lateral line.

Description of the type:

Depth 3½; head 4; D. 10; A. 19; scales 33, seven perforated. Slender, elongate; dorsal and ventral profiles equally arched. Head pointed, mouth small, oblique, the lower jaw slightly projecting; eye twice as long as snout, 2½ in head. Seven teeth in each intermaxillary, 2–3 in each maxillary, 10 in each side of the mandible. Maxillary little beyond vertical from front of orbit.

Origin of dorsal much behind ventrals, equidistant from tip of snout and middle of caudal lobes. Caudal moderately forked. Pectorals reaching to ventrals, ventrals not to anal. None of the rays filiform.

Straw colored, upper surface peppered with pigment cells, tip of lower jaw and snout dusky. No distinct markings.

In the table below is given the measurements of 16 specimens:

	Min.	Max.	Average.
Length in mm	34.0	41.0	36.11
Anal	19.0	23.0	
Depth	3.0	3.75	
Head	3.75	4.2	
Eye	3.0	3.33	
Perforated scales	6	9	
Teeth: Intermaxillary	13	16	
Teeth: Maxillary	2	3	
Teeth: Mandibular	18	20	

Scales 5 to 5.5–30 to 34–4.5 to 6.

63. *Hemigrammus melasopterus* sp. nov.

Type No. 10,039 (245), 37 mm. From Aguada, near Arroyo Trementina. December, 1900.

Co-types No. 10,040, one specimen (244), 35 mm. From Aguada, near Arroyo Trementina, December, 19 .

Co-types No. 10,041, five specimens (216), 29–35 mm. Taken in a trap in the Arroyo Pypucú. January, 1901.

A moderately elongate species. Depth 2⅔. Profile of snout abruptly rising, slightly concave at the nape, rising gently and convex to the origin of the dorsal. Lower jaw slightly projecting, maxillary toothless, long, extending obliquely downward and backward to the middle third of the eye. The upper edge of the opercle emarginate. The subopercle large.

Eye large, 2½ in head, ¾ in interorbital, ½ in snout.

Lateral line 34, incomplete, only the first five scales perforated.

The fins large. The height of the dorsal greater than the length of the head by ⅓ the diameter of the eye. Last dorsal ray 2⅓ in the highest ray.

Caudal deeply divided, its lobes subequal.

Pectorals reaching beyond the base of the ventrals.

Ventrals reaching beyond the origin of the anal.

Anal moderately high its entire length, its last ray $1\frac{1}{4}$ in the fourth ray, which equals the diameter of the eye.

Color: Top of head dusky. A deep V-shaped humeral spot. Dorsal almost black. The middle caudal rays black. The last five anal rays and the distal $\frac{2}{3}$ of the other rays black. The tips of the ventrals dusky. There is no caudal spot or lateral band.

In some of the co-types the tips and bases of the dorsal rays are white, the black band of the anal is narrower and the outer caudal rays are pigmented.

Related to *unilineatus* (Gill) and *elegans* Steind.

The following table of measurements shows the variations among the seven specimens:

	Min.	Max.	Average.
Length in mm	29.0	37.0	34.2
Dorsal	10.0	11.0	
Anal	27.0	28.0	
Depth	2.6	3.0	
Head	3.2	3.6	
Eye	2.4	2.5	

Scales 6.5 to 7.5–33 to 34–5.5 to 6.5.

14. Hemigrammus lütkeni Boulenger.

> *Tetragonopterus rivularis interrupta* Lütken, Velhas Flodens Fiske, XIII, 215, 1875 (preoccupied by *Tetraganopterus interruptus* Jenyns=*Cheirodon interruptus*).
> *Tetragonopterus lütkenii* Boulenger, Ann. and Mag. Nat. Hist., 1887 (Rio Grande do Sul).

Sixteen alcoholic specimens (29), the largest 35 mm. Estancia la Armonia.

Straw colored, a vertical humeral spot, a distinct caudal spot continued to the ends of the middle caudal rays, gradually narrowed and continued forward as a dark lateral band or line sometimes to the humeral spot, more frequently not so far.

Lateral line of the left side developed on 13, 24, 10, 13, 29, 11, 21, 10, 11, 25, 15, 10 (average 16) scales in as many individuals. In those with the longest lateral line some of the scales are simply notched, without a developed tube.

A large number of formalin specimens from Pypucú (219) and a few from Arroyo Trementina (253) differ from the above in that the dark lateral band or line abruptly joins the caudal spot, appearing as a marking independent from that spot, while in the specimens from La Armonia it seems to be a direct continuation of that spot. They are

much darker, which is probably due to the preservation and also to the locality. They differ also in having fewer scales with tubes.

Counts in 4 specimens from the Pypucú.

D.	A.	Scales.	Tubes in Lat. l.
12	25	7 –33–4	9
?	23	7 –33–5	9
10	21	7 –34–5	10
10	21	7½–35–5½	10

A number of other specimens from the Pypucú, taken at random, have the following number of tubes: 14, 15, 9, 18, 10, 12, 12, 13, 8, 11, 8, 13 (average nearly 12).

65. Hemigrammus kennedyi Eigenmann sp. nov. Tarcuí.

Type No. 10,016, a specimen 57 mm. long (159). Campo Grande. February, 1901.

Co-types No. 10,063, 5 specimens taken with the type at Campo Grande.

Co-types No. 10,012, twenty-five specimens (267). Campo Grande. June, 1901.

Co-types No. 10,019, ten specimens (268). Campo Grande. June, 1901.

Co-type No. 10,018, one specimen (241). Arroyo Trementina.

This species closely resembles *Pœcilurichthys multiradiatus* Steind. It differs widely from all other species of *Hemigrammus.*

Description of type:

Head 4⅓; depth 2⅛; D. 10; A. 46; scales 10–45–8.

Compressed, ventral profile regularly arched, its lowest point between ventrals and anal; dorsal profile depressed at nape, angulated at the origin of the dorsal.

Eye large, ½ in snout, 2⅓ in head, 1 in interorbital. Mouth small, maxillary reaching to eye, no teeth on its margin.

Suborbitals covering the entire cheek. Scales largest over pectorals. Lateral line extending, with interruptions increasing in size and frequency, to the last fourth of the anal.

Dorsal midway between tip of snout and caudal, directly over origin of anal; caudal deeply forked; anal low and long, its length slightly exceeding the height of the body; ventrals reaching to anal, pectorals beyond origin of ventrals.

A dark spot at base of caudal, a narrow dusky lateral band. Base of caudal rays and a spot just above the origin of the lateral line yellow.

The co-types vary in some respects from the description given above. Anal 40–46; Lat. l., 40–45. In a few specimens there is a blackish

ımeral spot just above the origin of the lateral line. The lateral ıe varies considerably in the degree of completeness. In three speciens at least it extends to the caudal, but is interrupted. In the marity it stops far short of the caudal.

. **Pœciliurichthys scabripinnis** (Jenyns).

One specimen, 32 mm. (part of 219), Arroyo Pypucú. One speci-en (228), Arroyo Chagalalina.

Scales 7–35–5; D. 11; A. 26–29; head $3\frac{3}{5}$; depth $2\frac{3}{4}$.

One tooth on the maxillary; a conspicuous lateral band from eye the end of the middle caudal rays, diffuse on the head, narrow on the les in front, darkest and widest on the caudal peduncle. No humeral ot. Back with numerous pigment cells.

Compressed. Mouth small, maxillary not reaching beyond anterior ırgin of eye. Eye $2\frac{1}{2}$ in head, greater than interorbital, snout $1\frac{1}{2}$. Origin of dorsal behind ventrals, nearer caudal than tip of snout. ıal not falcate. Pectorals about to ventrals, ventrals to anal.

These specimens differ distinctly from *scabripinnis* in color, having :onspicuous black band. They were, however, preserved in formalin, ıich has a tendency to destroy the silvery structural bands and to ing out the underlying black pigmentary markings. The species evidently closely related to *wappi* from British Guiana.

Pœciliurichthys multiradiatus Steind. Mojarra.

Ten specimens, 39–93 mm., from Asuncion (14, 70, 93, 137, 38, 168). ıese specimens differ from the typical *multiradiatus* of the Amazons the number of rays and scales.

Anal 41–45 (40–41 in specimens from Teffe, the type locality).

Lat. line 45–47(41–42 in the types). Depth 2–$2\frac{1}{4}$ (2).

Caudal spot distinct, becoming faint with age; humeral spot indisıct or absent. Maxillary toothless, or with a single rather large ducous tooth near its upper end.

It is possible that these specimens represent a distinct species.

. **Pœciliurichthys abramis** Jenyns. Mojarrita.

Three specimens, Asuncion (11); Arroyo Trementina (246).

Humeral spot oval, distinct; A. 30 and 32; scales 10–46–9 and 44–9. This species is very similar to *lacustris*.

. **Pœciliurichthys maculatus lacustris** Lütken. Mojarra.

Twenty-three specimens, Asuncion (88, 84, 12), Estancia La Armonia 6), Arroyo Trementina (181, 251, in part 243).

Anal 27–31; lat. l., 37–40. In a number of specimens there is a ack spot at the base of each scale of the sides, forming longitudinal ripes.

70. Pœcilurichthys dichrourus Kner.

Six specimens (No. 7 in part), Asuncion, Rio Paraguay. November, 1899. "Edible; taken in a fish trap; commonly called Piki."

Two specimens (251 in part), creek near Arroyo Trementina.

These specimens are slenderer than Kner's figure. There is a faint caudal spot. The middle caudal rays and the distal half of each caudal lobe black. Maxillary with one or two small teeth.

The following table shows the measurements of the eight specimens:

	Min.	Max.	Average.
Length in mm	34.0	48.0	41[illegible]1
Anal	24	28	
Depth	3.0	3.75	
Head	3.5	4.0	
Eye	2.4	2.6	

Scales 5.5 to 5.5–34 to 39–4.5 to 5.

71. Pœcilurichthys agassizii Steindachner.

Four specimens, Arroyo Trementina (240); Arroyo Chagalalina (2[illegible]9).

Head $3\frac{1}{3}$–$3\frac{1}{2}$; depth $2\frac{2}{3}$–$2\frac{1}{2}$; eye $2\frac{2}{3}$–$2\frac{3}{4}$ in the head; A. 24–26; L. lat., 25.

72. Pœcilurichthys moenkhausii sp. nov.

Type No. 10,001, a specimen 43 mm. (251 in part), a brook near Arroyo Trementina.

Co-type No. 10,002, one specimen (251 in part), taken with the type.

Co-types No. 10,003, nine specimens (255), a brook near Arroyo Trementina.

This species is related to *Tetragonopterus paucidens*, from which it differs in the depth, the greater number of scales and absence of caudal spot.

A symmetrical, elongate species. Depth $3\frac{1}{2}$. Snout blunt. The dorsal and ventral profiles of the head alike. Body deepest just before the ventrals, tapering gently both above and below to the caudal. Scales moderate. Lateral line complete.

Head short, 4 in the length, its depth $1\frac{1}{4}$ in its length. The opercle narrow, its width more than 2 in its depth. The maxillary moderately long, extending to beneath the anterior rim of the orbit, two small teeth in its upper end.

The eye moderately large, 3 in the head, 1 in the interorbital.

Dorsal rays 9. Height of dorsal slightly less than the length of the head. The origin of the dorsal falls just back of the insertion of the ventrals.

Caudal moderate, the depth of the cleft about ⅗ the length of the ›bes.

Anal moderately long, its first 5 rays high, equal to distance from p of snout to posterior margin of preopercle; the last half of the anal ıt ⅓ as high.

Pectorals small, reaching ¾ distance to ventrals.

Ventrals small, reaching ⅔ distance to origin of anal.

In formalin the specimens are almost without color. In some the iddle caudal rays are dusky, and a grayish band, probably silvery life, extends from the base of the caudal to the humeral region. ıe fins are immaculate.

Scales 5½–37–4½; A. 19–26; D. 9; depth 3½; head 4; eye 3. The llowing table gives the measurements of eight specimens:

	Min.	Max.	Average.
›ngth in mm	37.0	46.0	40.5
epth	3.5	3.75	
ead	4.0	4.0	
ye	2.5	3.0	
›eth in maxillary	2	2	
nal	19.0	26.0	

Scales 4.5 to 5.5–35 to 38–4 to 4.5.

. **Tetragonopterus orbicularis** Cuv. and Val.

Four specimens (252), Arroyo Trementina. It is possible that these ›ecimens are the young of *chalceus*. Depth 2 in the length; Lat. l., 35.

. **Tetragonopterus chalceus** Agassiz. Mojarra.

Tetragonopterus rufipes Val. in D.Orb. Voy. Amer. Merid. Poiss, Pl. 11, fig. 1.

Four specimens, Asuncion (86, 13); Arroyo Trementina (256). Anal –37; lat. l., 30 or 31.

The description of *rufipes* makes it a distinct species, but the figure ıows it to have an anal much shorter than that described.

. **Bryconh hilarii** (Cuv. and Val.).

Chalceus hilarii Cuv. and Val., XXII, 246, 1848; Castelnau Anim. Amer. Sud. Poiss., 68, Pl. 36, fig. 1, 1855: Kner, Denksch. Acad. Wien, 1860, XVIII, 10.

Brycon hilarii Günther, Cat. Fish Brit. Mus., V. 336, 1864.

Chalceus orbignyanus Cuv. and Val., XXII, 249, Kner, *l. c.*, 11. (Rio de la Plata, Rio Guaporé.)

One specimen (194), 21 cm., Arroyo Trementina.

Head 4½; depth 3½; D. 11; A. 27; V. 8; P. 14; scales 15–75–12.

A robust species. Body moderately deep, depth 3½. Upper pro- e of head nearly straight to base of occipital process, where the profile ses slightly more rapidly for about ⅓ way to the origin of the dorsal; ıe other ⅔ almost straight and rising to the origin of the dorsal at a

very low slope. From the last ray of the dorsal to the adipose almost straight. Caudal peduncle deep, compressed. Ventral profile evenly curved from the isthmus to the origin of the anal. Belly rounded to the ventrals, keeled between the ventrals and the anus.

Head short and heavy, 4½ in total length, height to base of occipital process 1¼ in length.

Eye large, 3⅘ in head, 2 in the interorbital. Snout short, equal to eye, 3⅘ in head.

Each intermaxillary with an outer series of about 9 small, even tricuspid teeth. Behind each of these runs a more irregular series of slightly larger tricuspid teeth. Behind the inner ends of these 4 runs a cross series of about 4 or 5 larger five-cuspid teeth. Maxillaries narrow, straight, not sheathed by the preopercle, each with a single series of fine teeth extending about ⅔ its length. Mandible with an outer series of tricuspid teeth, the forward 6 on each side much larger than the others. Of these six the second is the largest, the first and third are equal, the others are smaller. Just behind the center of this series are 10 very small conical teeth.

The upper lip is very thin and adnate. The lower is thick and free, and at the outer ends it thins out and the free edge turns down to join the point of the maxillaries.

The tongue is thick, soft and adnate. The rami of the dentary wide apart; the four branchiostegals exposed. Gill-rakers setiform, gill-membranes united in front but free from the isthmus. The longest ray of dorsal 5 in length. Origin of dorsal in the middle of the length, just back of the insertion of the ventrals; the shortest ray 3 in the longest.

Pectorals 1⅘ in head, not reaching ventrals. Ventrals 1½ in the head, reaching the anus. Anal moderately high, its last ray 1⅘ in the third, the latter ⅔ of the anal sheathed by scales for about ⅓ its height.

Caudal but slightly indented; its middle ray 2⅔ in the head.

Adipose over the last anal rays.

Color in formalin: Flesh color, darker above; a faint humeral spot and a large black spot at the base of the caudal and extending to the ends of the middle caudal rays. An indistinct blotch on the opercle. The snout and top of the head dark. A faint suggestion of longitudinal striations following the lines of scales.

76. Chalcinus angulatus curtus Garman. Pira guira.

Nine specimens, Asuncion (146, 75); Estancia La Armonia (26); Arroyo Trementina (184); Campo Grande (266).

77. Gasteropelecus stellatus Kner.

Nine specimens (69), Laguna Pasito, Asuncion.

78. Characinus gibbosus (Linn.).

Three specimens (192), Laguna of Arroyo Trementina.

Head $3\frac{3}{5}$–$3\frac{5}{6}$; depth $2\frac{2}{5}$–$2\frac{3}{5}$; lat. l., 55–59; D. 10 or 11; A. 50–53.

79. Characinus squamosus sp. nov.

Type No. 9,961, a specimen (72), 215 mm., Pasito Laguna. This species is at once distinguished by its small scales and long anal.

Head 4; depth $3\frac{2}{5}$; D. 12; A. 54; P. 14; V. 8; lat. l., 112.

Profile nearly straight from tip of snout to nape. At the nape it rises abruptly for about $\frac{1}{4}$ of the distance to the dorsal, from which point to the origin of the dorsal the slope is very gradual. The slope of the back from the origin of the dorsal to its last ray is downward and rather steeper than from the dorsal to the caudal peduncle, which slope is also very slightly convex.

Lower sides of body evenly curved from the tip of snout to vent. The base of the anal nearly straight.

Anterior portion of the head shaped very much as in *Cynopotamus kneri.*

Snout elongate, 3 in length of head. Eye large, $4\frac{3}{5}$ in head, $1\frac{1}{3}$ in interorbital.

A narrow, unscaled, occipital process equal to the snout in length. Suborbitals moderate, only half covering the lower part of the preopercle. The angle of the preopercle rounded, not with a backwardly projecting angle as in *C. gibbosus.*

Maxillary almost straight, reaching far beyond the eye, finely toothed its entire length. Mandible when closed shorter than snout.

Premaxillary teeth in two series; the outer contains 2 canines in front and a smaller one on each side at the end of each premaxillary bone; the inner series of two smaller canines on each side. Maxillary with a single series of teeth its entire length.

Mandibular teeth in a single series in the following order: 1st, ten minute teeth; 2d, a canine corresponding to the upper front canine; 3d, a small canine pointing obliquely upward and outward; 4th, a large canine fitting into a cavity in the upper jaw; 5th, a small canine corresponding to the upper posterior canine and followed, 6th, by a series of closely set small teeth.

Dorsal slightly falcate, its longest ray 5 times in total length to tip of middle caudal rays. Pectorals to middle of ventrals. Ventrals not reaching origin of anal. Anal long and low, its fourth ray the longest, $2\frac{1}{3}$ times length of last ray. Caudal forked, scaled well up on the lobes.

Lat. line 112, almost straight, very slightly decurved in front.

[8]3. Acestrorhynchus[6] falcatus (Bloch).

Salmo falcatus, Bloch, taf. 385.
Xiphorhynchus falcatus Agassiz, Selecta Genera et Species Pisc., 76, 1829; Cuv. and Val., XXII, 337; Castelnau, 75 (Amazon).
Xiphorhamphus falcatus Müller and Troschel, Hor. Ichthyol, I, 17, 1845 (name only); *id.* in Schomburgk Reisen in Brit. Guiana, 635, 1848 (Essequibo, Pomeroon); Kner, Denkschr. Acad. Wiss. Wien, XVIII, 57, 1860 (Matto Grosso); Günther, Cat. Fish. Brit Mus., V, 354, 1864; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 58.
Xiphorhamphus ferox Günther, Ann. and Mag. Nat. Hist., XII, 443, 1863 (Essequibo); Günther, Cat. Fish. Brit. Mus., V, 355 (Essequibo); Boulenger, Trans. Zool. Soc. Lond., XIV, Pt. II, 37, 1896 (Paraguay).

The *X. ferox* of Günther differs from *falcatus* chiefly in the length of he maxillary, also in the size of the eye, the scales, etc. Both species ave been found in the Essequibo river. We have four specimens 33 and 49), ranging from 22 cm. to 27 cm., from the Rio Paraguay at suncion. There is no doubt that these specimens belong to the same pecies. Their measurements are as follows:

7 cm. A. 24, Scales 107, Eye $6\frac{1}{2}$, Snout [$2\frac{2}{3}$, Depth $3\frac{3}{5}$, Max. 1 diam. beyond eye.
5 cm. A. 27, Scales 106, Eye 6, Snout $2\frac{3}{5}$, Depth $3\frac{3}{5}$, Max. 1 diam. beyond eye.
3 cm. A. 27, Scales 97, Eye $5\frac{4}{5}$, Snout $2\frac{4}{5}$, Depth $3\frac{4}{5}$, Max. $\frac{1}{3}$ diam. beyond eye.
2 cm. A. 27, Scales 103, Eye $5\frac{4}{5}$, Snout $2\frac{2}{3}$, Depth 4, Max. $\frac{2}{3}$ diam. beyond eye.

The measurements nearly bridge the differences said to exist between *alcatus* and *ferox* in the number of anal rays, the scales and length f the maxillary. We have, therefore, placed *ferox* provisionally in he synonymy of *falcatus*, of which it is probably the young. A specinen of *X. falcatus* in the collections of the Indiana University from "Brazil," 22 cm., differs from our smallest specimen in the shape of he mouth and the extent of the maxillary. The maxillary extends or a distance equal to $\frac{2}{3}$ diameters of the eye beyond its posterior order. This difference is in part due to the greater length of the naxillary, and also in part to the fact that it makes less of an angle where it joins the premaxillary.

In the absence of specimens from the Rio San Francisco the *X. lacustris* of Reinhardt is kept distinct. It is unquestionably a local race of *falcatus*, if it is not identical with it.

84. Acestrorhamphus[7] hepsetus (Cuv.) Blanquillo.

One specimen (15), Laguna at Asuncion. As this specimen differs from the available figures of *hepsetus*, especially in the pectoral, and may represent a distinct species, a description is added.

Head $3\frac{3}{5}$; depth $3\frac{1}{2}$; D. 11; A. 30; scales 13–75–10.

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[6] New for *Xiphorhynchus* Agassiz, preoccupied.
[7] New for *Hydrocyon hepsetus* Cuv.

Ventral serræ in the co-types 34 and 36; of these there are in one 22 simple spines, 9 with a double (anterior and posterior) tip and 3 bilateral ones; in the other there are 21 + 11 + 3.

Form nearly circular. The dorsal profile is very slightly concave at the occiput and the ventral profile about equally concave at the isthmus. Lateral line but slightly decurved near its anterior end.

The distance from the origin of the dorsal to the lateral line ⅔ distance between lateral line and lowest point of the ventral profile.

Supraoccipital process extending ⅓ to origin of dorsal.

Length of head less than its depth by ⅓ diameter of eye. Posterior outline of opercle much flattened, its width 3½ in its depth. Suborbitals very narrow, leaving the cheek entirely naked. Maxillary oblong, directed straight downward. Mandible with an outer row of 10–12 strong teeth with oblique cutting edges and an inner row of 2 conical teeth at the symphysis. Premaxillary with an outer row of 6–8 medium-sized teeth similar to those in the mandible, and an inner row of 6–8 heavy broad-tipped teeth close against the outer row and alternating with them. The outer row lacks the middle tooth.

Snout equals ½ diameter of eye. Eye large, 2½ in head, 1⅓ in interorbital.

Base of dorsal 1⅓ in its height, which equals depth of head.

Distance between dorsal and adipose dorsal 1½ in base of dorsal, 1 in base of adipose. Height of adipose about 3½ in its length.

Caudal broad, widely emarginate, its middle rays 3 times in distance between tips of its lobes. Caudal peduncle small, its depth equal to diameter of eye.

Pectorals small, 1½ in head. Ventrals very small and narrow, equal to pectorals, not reaching vent.

Anal slightly lower at its posterior end than at its anterior, its posterior margin slightly convex.

Color light brown, with 7–8 irregular bars and a few indistinct spots of darker above the lateral line. Fins immaculate.

This species stands nearest to *M. lippincottianus*, from which it differs in the greater depth, in the more evenly rounded ventral profile and in a narrow subopercle.

89. Myleus tiete Eigenmann and Norris.

A specimen of this species was overlooked when the report on the fishes of S. Paulo, Brazil, was prepared (*Revista do Museu Paulista*, IV, 1900). The type was but 30 mm.; the present specimen is much larger, measuring 155 mm. It differs from the type considerably in proportions and in color.

ee. Anal spines 6. Dorsal spines 15 or 16. Preorbital less than orbit in width. Scales on cheek in 3 or 4 series. Soft dorsal and anal scaled, ... 2. CHÆTOBRANCHOPSIS.

dd. Gill-rakers stiff, lanceolate, crenulate on inner margin. Perciform. Scales small. Spinous and soft dorsals of nearly equal extent, and separated by a notch. Anal spines 3. Each jaw with a broad band of villiform teeth. Dorsal and anal fins scaled, 3. CICHLA.

cc. Gill-rakers short and few.

f. Vertical limb of preopercle entire.

g. Scales of the lateral line much longer than the others. About 2 transverse series of scales in the anterior part to each scale of the lateral line. First series of teeth incisors, separated from the rest by a moderate space, ... 4. UARU.

gg. Scales of the lateral line not larger than the others.

h. A series of incisors, a band of villiform teeth behind them. Anal with 8 spines, ... 5. NEOTROPLUS.

hh. Teeth all conical, the front series remote or not.

i. Premaxillary very greatly protractile.

j. Anal spines 3.

k. Lateral line not overlapping. Snout equal to postorbital portion of head. Mouth oblique, preorbital narrow ($\frac{1}{2}$ orbit). Nostrils nearer tip of snout than eye, ... 6. ACAROPSIS.

kk. Lateral line with the upper and lower limbs overlapping. Snout much produced, more than twice the length of postorbital portion of head. Preorbital very large, nearly twice as wide as the eye. Nostrils much nearer orbit than tip of snout. Mouth low, nearly horizontal. Premaxillary an orbital diameter below the eye. Caudal densely scaled. Maxillary reaching to nostrils, ... 7. RETROCULUS.

jj. Anal spines 6. Snout not greater than postorbital portion of head. Preorbital narrow. Mouth oblique, premaxillary on level of lower third of eye, more protractile than in the other genera. Maxillary reaching to front margin of eye. The origin of the ventral falls vertically below that of dorsal, . . 8. PETENIA.

ii. Premaxillary comparatively little protractile.

l. Ventrals inserted behind origin of dorsal.

m. Cheeks scaled.

n. Jaws subequal.

o. Anal spines 3.

p. Soft portions of vertical fins densely scaled to near the tip; dividing line between fins and body indistinct. About 6 of the anterior teeth of lower jaw enlarged canines, . . . 9. ASTRONOTUS.

pp. Soft portions of dorsal and anal naked or scaled on base only. Caudal scaled at its basal half. Lower jaw without enlarged canines, ... 10. ÆQUIDENS.

oo. Anal spines more than 3, some of the teeth usually enlarged, often canine-like.

q. Lower lip with a frenum, its folds interrupted mesially, . 11. CICHLOSOMA.

. Anal spines 4 to 9, ... (CICHLOSOMA).
. Anal spines 10 to 11. . . . . (ARCHOCENTRUS).
. Lower lip without frenum, forming a free fold for its whole length, 12. HEROS.
. Upper jaw projecting. Anal spines four. Cleft of mouth short. Scales on cheek small, in more than 5 series, . 13. THERAPS.
n. Head entirely naked. Scales of nape very small, extending to the occipital region. Scales large, lateral line 24+15. Mouth large. Nares very minute, at the tip of the snout. Gill-membranes united to the isthmus; gill-rakers small, 14. BOGGIANIA.[10]
. Ventrals in front of origin of dorsal, ... 15. MESONAUTA.
. Vertical limb of preopercle serrate.
. Jaws equal. Scales rather large, those of the lateral line equal ordinary scales in size.
. Body short and deep as in *Astronotus*, . . . 16. CRENICARA.
. Body elongate, as in *Crenicichla*, ... 17. DICROSSUS.
. Lower jaw much projecting. Mouth wide, snout depressed. Fewer scales on the lateral line than in the series just above it, 18. CRENICICHLA.
. First gill-arch with a downward projecting lobe on its upper limb, the rakers carried on the free margin of this limb (eggs carried in the gill chamber).
. Preorbital not deeper than eye. Eye equidistant from tip of snout and upper angle of gill-opening, ... 19. BIOTODOMA.[11]
. Preorbital in adult prolonged, much deeper than the eye. Eye placed high, much nearer upper angle of gill-opening than tip of snout, ... 20. GEOPHAGUS.
. Base of dorsal fin without scales, ... 21. (SATANOPERCA).
. Base of dorsal scaled, ... 22. (GEOPHAGUS).
. Soft portion of dorsal longer than spinous portion.
. First gill-arch with a downward projecting lobe above, as in *Geophagus*. Anal spines 3, dorsal spines 7 or 8. Body very long. Preopercle entire. . . . . 23. BIOTŒCUS.[12]
. First gill-arch normal. Body short and deep.
. Gill-rakers obsolete. Anal spines 6 to 10. Covered with small ctenoid scales. Soft dorsal and anal scaly. Teeth small, occupying only the symphyseal portion of jaw. Mouth small, very oblique, ... 24. SYMPHYSODON.
. Gill-rakers setiform. Anal spines six, graduated. Narrow bands of teeth in the jaws. Mouth small, oblique. Anterior

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[10] ***Boggiania***, Perugia, *Di Alcuni Pesci Raccolti nell' alto Paraguay*, 2, 1897 ***ellata***).
This genus is by Perugia considered to be closely related to *Crenicichla*, but if description is correct it is very different from this genus or any other genus of s family.

[11] ***Biotodoma***, new for ***Mesops***, which is preoccupied in Coleop., 1820. βιοτος ing δωμα, a home, in allusion to their habit of carrying the young in the gills.

[12] New for *Saraca*, preoccupied in Lepid. 1865, βιοτος, living, οικος house, a me; in allusion to their habit of carrying their young in their gills.

parts of soft dorsal, anal, and first ventral ray much prolonged.
Caudal truncate, ... 25. PTEROPHYLLUM.

101. Æquidens tetramerus Heckel.

Many specimens from Rio Branco (102); Campo Grande (153); Estancia La Armonia (22); Arroyo Trementina (183, 250); Arroyo Carumbey (20); Tolducuc (232, 233); Salamanca (258).

D. XV, 10 or 11; A. III, 8–10; lat. l., 14–18+7–9.

102. Æquidens paraguayensis sp. nov. Pira mbocaya.

Type No. 10,066, a specimen, 100 mm. (part of 66), Asuncion.

Co-types No. 10,067, nine specimens (66), Asuncion.

Co-types No. 10,068, five specimens (169), Laguna Asuncion.

Co-types No. 10,069, five specimens (190), Asuncion (?).

Co-types No. 10,070, ten specimens (238), Aquadas.

Other specimens are No. 10,071 (218), two Arroyo Pypucú; No. 10,073 (271), one Asuncion; No. 10,074 (217), four Arroyo Pypucú.

This species is evidently very closely related to *Æquidens dorsigera* (Heckel) and *Æquidens syspilus* (Cope). Steindachner states that *dorsigera* is characterized by a black spot on the spinous dorsal, which was present in all the numerous specimens examined by him. None of the specimens of the new species have such a spot. From *syspilus*[13], as far as the meager figure and description of Cope permit a comparison, this species differs chiefly in the number of scales and rays.

Description of the type:

Dorsal XIV, 9; A. III, 7; lat. line 16+10 (24 in the series which carries the posterior segment of the lateral line). Head 2⅗; depth 2⅛.

Elevated in front, head broad, eye above the tip of the snout, preorbital equals eye. Eye 3¼ in head, 1 in snout, slightly less than interorbital. Cheeks with three rows of scales; scales of the body large, of nearly uniform size. The middle rays of the soft dorsal and anal prolonged, reaching beyond middle of caudal, the longest dorsal ray reaching from tip of snout to second fifth of the pectoral. Caudal rays

[13] Cope's description, *Proc. Acad. Sci. Phila.*, 1871, p. 255, of *syspilus* from the Ambyiacu is as follows:

"Scales in three series on the cheeks, on the body 2–26–7. Radii D. XIV-XV, 9; A. III, 8; caudal rounded. Form elongate oval; depth of body 2.6 times in length without caudal fin, and equal depth of head. Preorbital bone half orbit (in specimen two inches long); orbit 2.5 times, head nearly twice interorbital space (doubtless much smaller in larger specimens). Profile convex; muzzle oblique; upper lip longer than mandible.

"Light brown, yellow below. A straight wide black band from the upper posterior margin of the orbit to below the end of the spinous dorsal, composed of three confluent spots; a black bar from eye to angle of preoperculum, and another across the base of the caudal fin. Seven vertical brown cross shades behind the head, on sides."

oduced, filamentous. Dorsal spines of nearly uniform height, equal ⅗ the length of the head. Outermost ray of the ventrals produced, aching to the end of the base of the anal. Pectorals reaching beyond igin of anal.

A series of faint cross-bars on the sides, a black band from the upper rt of the eye to near the end of the spinous dorsal, much narrower the head than on the body. A large black spot in the lateral band ar the middle of the body. A dark band down and slightly back from e eye; a dark band across forehead. A black spot on upper half of se of caudal.

Other specimens differ from the type in some respects. Among all e specimens examined but one had XIII; one had XV instead of XIV rsal spines; a few had 10 rays in the dorsal. The anal rays varied om 6–8. The tubes of the lateral line varied from 14–17 on the ante- r limb and from 6–10 on the posterior.

The color varies much in intensity and the median lateral spot and r down from eye are more conspicuous in the young than in the ult, while the lateral band is much less conspicuous in the young.

3. Mesonauta festivus (Heckel).

Two specimens (182), from a Laguna near Arroyo Trementina.

4. Crenicichla lepidota Heckel.

Seven specimens, Rio Branco, Matto Grosso (105); Campo Grande 56 and 157); Laguna near Arroyo Trementina (188); Arroyo Chaga- ina (224); Arroyo Trementina (249).

5. Crenicichla saxatilis (Linn.).

One specimen (10), Laguna of Rio Paraguay.

3. Geophagus duodecimspinosum Boulenger. Pira mbocaya.

Eight specimens (3, 67, 76, 141), from the Laguna at Asuncion. ere can be no doubt about the identification of the specimens before with Boulenger's species, although none of them agree with the type the number of spines. Boulenger gives D. XII, 14; A. III, 9; lat. e 18+9. Our specimens have the rays and scales as follows:

D. 13–14	A. III, 8	Lat. l. r. 20+12
D. 14–13	A. III, 9	Lat. l. r. 20+12
D. 13–13	A. III, 8	Lat. l. r. 21+11
D. 13–13	A. III, 9	Lat. l. r. 18+ 9
D. 13–15	A. III, 9	Lat. l. r. 21+11
D. 14–13	A. IV, 8	Lat. l. r. 20+11
D. 13–13	A. III, 7	Lat. l. r. 19+ 9
D. 14–12	A. III, 8	Lat. l. r. 21+ 8

The lateral line is interrupted at the caudal, being continued along

the lower lobe of the caudal fin. The caudal is obliquely truncate or slightly emarginate, the upper lobe being the longer. Sides with obscure cross-bars, otherwise as in the type.

107. Geophagus pappaterra Heckel.

One specimen (185), from the Laguna near the Arroyo Trementina.
D. XVI, 10; A. III, 6; lat. line 19+10.

108. Biotodoma trifasciatus sp. nov.

Type No. 10,066, a single small specimen, 29 mm. (225), Arroyo Chagalalina.

Head 3; depth $2\frac{3}{4}$; D. X, 6; A. III, 5; lat. line, 7+9. 22 scales along median line. Streak along base of dorsal; lateral band from tip of snout to caudal spot; a narrow, well-defined oblique band from lower margin of pectoral to origin of anal and continued to tip of first ray dark; an oblique bar from eye down and back, outer rays and most of the base of the ventrals jet black, the rest of the fin colorless. Pectorals and caudal dusky. Dorsal with a black margin; anal dusky except the streak mentioned above, which is black. Fins yellow in life. Eye nearer snout than gill-slit, $\frac{3}{5}$ in snout, about $2\frac{3}{4}$ in head. Supplementary flap of first gill-arch well developed. Scales large; lateral line not well developed, the anterior part with only nine developed tubes, the last one of which is under the anterior half of the dorsal, only a partial scale between the last developed tube and the dorsal. Pectorals reaching to vent, ventrals to anal, soft dorsal and anal to caudal.

109. Achirus jenynsii Günther. Lenguado, Pira Kigua.

Six specimens (38, 42, 143), Asuncion, Rio Paraguay. March, 1900.

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The collection and study of fishes has been more active in the southern part of South America during the last fifteen years than in the northern. Several papers have appeared during this time on the fishes of Rio Grande do Sul, a larger number dealt with the fishes of one part or another of the La Plata system. None of these papers offer a comprehensive account of the fishes of the system, being rather reports on definite collections. We give below a list of the papers dealing with fishes of the La Plata basin published since 1890. The earlier papers are given in Eigenmann and Eigenmann, 1891.

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EINDACHNER. 1891. Ueber Einige Characinen Arten aus Südamerica, *Ichthyol. Beitr.* XV, 22.

A COLLECTION OF REPTILES AND BATRACHIANS FROM ARKANSAS INDIAN TERRITORY AND WESTERN TEXAS.

BY WITMER STONE.

During the months of March and April, 1903, Dr. Henry A. Pilsbry made a zoological reconnaissance in the Ozark Mountain region of southwestern Missouri and southern Arkansas, visiting also parts of Indian Territory and Texas, in the interests of the Academy. Among the material collected on the trip is an interesting series of reptiles and batrachians, which it has been my privilege to study and of which I herewith present a list.

While none of the forms appear to be new, the appended records are of much interest as a contribution to our knowledge of the distribution of species in a region which has been but little explored. I have also added notes on such individual variations as the specimens present, and in the case of the serpents have recorded the number of the caudals and ventrals in the largest and best preserved specimens, which may prove of value in studying the relationship of closely allied geographic races.

BATRACHIA.

Typhlomolge rathbuni Stejneger.

Six specimens from San Marcos, Hays county, Tex.

Obtained by Mr. John A. Leary from artesian wells, 152 feet deep.

Plethodon cinereus (Green).

Chadwick, Mo. (2); Roger (2), Magazine Mt. (9), Ark.

Plethodon glutinosus (Green).

Chadwick, Mo.; Blue Mt. Station (3), Magazine Mt. (3), Petit Jean Mt. (3), Ark.

Diemyctylus viridescens Raf.

Wister, I. T.

This specimen has the red lateral spots and seems to be typical *viridescens*.

Bufo valliceps Wieg.

San Antonio, Tex., one specimen.

eris gryllus (Le Conte).

Hartford, Ark.; Wyandotte (2), I. T.; San Marcos (2), New Braun-els (2), Del Rio, Tex.

yla arenicolor Cope.

One specimen from Del Rio, Tex., which seems to be referable to iis species.

agystoma carolinense Holbrook.

One specimen from San Marcos, Tex.

ana virescens Kalm.

High Bridge (2), New Braunfels (3), Devil's river, Tex.

REPTILIA.

errapene major (Agassiz).

One specimen from Devil's river, Tex.

While I have no material for comparison, this specimen agrees with [r. Taylor's description (*Pr. U. S. N. M.*, 1894, p. 576), and certainly an be referred to none of the others recognized in his monograph. he locality is much farther west than any recorded in Mr. Taylor's aper, the nearest point from which he had a specimen being Galveston.

errapene triunguis (Agassiz).

A specimen from Limestone Gap, I. T., seems to be referable to this ecies. Mr. Taylor (*l.c.*, p. 581) states that "the Louisiana form ems to be a dwarf variety of this species," as noticed by Agassiz, and series of twelve recently received from Avery's Island, La., through e kindness of Mr. E. A. McIlhenny, support this view. Inasmuch Agassiz's type of *triunguis* came from Louisiana, it is the larger rm that must be supplied with a name, should such a separation be emed desirable.

The Indian Territory specimen before me is dull olive-brown, with iore or less obscure yellowish radiating lines or blotches on the plates f the carapace, while the plastron is yellow mottled with small brown pots.

The Louisiana specimens vary from this same style of coloration o dark brown with small rounded bright yellow spots, arranged some-hat in radiating lines but entirely disconnected, plastron usually lain dull yellowish, sometimes with obscure transverse and radiating ands of brown; spots on the head bright yellow and reddish-orange.

The proportions of the two forms are as follows:

	Length of carapace.	Greatest width.	Height.
No. 15,607. Limestone Gap, I. T.	4.50 ins.	3.50 ins.	2.66 ins.
Avery's Island, La.................	4.12 "	3. "	2.37 "

es, presenting a somewhat different appearance from those recently scribed from Alamogordo, N. M.[1]

lepisma laterale (Say).

Obtained from Poteau and Petit Jean Mt., Ark.; Sugar Loaf Mt., yandotte and Limestone Gap, I. T., and New Braunfels, Tex.

meces quinquelineatus (Linn.).

A large series representing all age variations from Chadwick, Mo.; tit Jean Mt., Magazine Mt., Blue Mt. Station, Ark.; South McAlester, mestone Gap, Sugar Loaf Mt., Wyandotte and Wister, I. T.

mnophis proxima (Say).

Collected at High Bridge, Pecos river; New Braunfels and Devil's er, Tex.

The New Braunfels specimen has the dorsal stripe deep red.

Ventrals 165, 167, 174. Caudals 84, 95.

trix sipedon transversa (Hallowell).

Four specimens from Devil's river and one from Honda, Tex. If s and other races of water snakes are to be considered subspecies one group, *sipedon* must be used as the specific name, as already opted by Mr. A. E. Brown, as it occurs in the tenth edition of nnæus, while *fasciatus* does not appear until the twelfth.

Only the young specimens seem to have the transverse spots well rked.

Ventrals 145 (2), 147 (2), 153. Caudals 69, 71, 79, 82, 83.

trix sp.

One very young specimen from Uinta, I. T., seems to differ from *s. transversa.* Nearly uniform brown above with an obscure light rsal stripe, plain whitish below. Ventrals 130. Caudals 45.

adora grahamiæ Bd. and Girard.

One specimen from New Braunfels, Tex. Ventrals 180. Caudals

dophis arnyi Kennicott.

Ten specimens from Chadwick, Mo.; Magazine Mt., Ark., and Sugar af Mt., I. T.

This series is quite uniform in color and pattern and the first row of les is blue-gray in all. It seems very questionable whether this is ntical with the collarless *D. regalis* of Chihuahua, and until we ow more of the Mexican representatives of the genus it will be best use Kennicott's name, which was based upon a specimen from Hyatt,

[1] *Proc. A. N. S., Phila*, 1902, p. 32.

Kans. The *Diadophis* from Hennessy, Okla., obtained by Prof. Cope in 1893, are all *D. amabilis docilis* (Bd. and Girard). Ventrals (Arkansas specimens) 156, 158, 167. Caudals 43, 49, 49.

Lampropeltis doliatus coccineus (Schlegel).

Petit Jean Mt., Ark.; Limestone Gap (2), South McAlester, I. T.

Ventrals 189, 193, 194, 196. Caudals 45, 46, 49, 49.

Lampropeltis getulus sayi (Holbrook).

Sugar Loaf Mt., I. T.

Ventrals 110. Caudals 51.

Carphophiops vermis Kennicott.

Chadwick, Mo.; Magazine Mt., Roger, Poteau and Blue Mt. Station (2), Ark., and Wister, I. T.

All bright salmon below posteriorly; paler anteriorly.

Ventrals 130, 130, 137, 137. Caudals 34, 34, 26, 27.

Virginia elegans Kennicott.

One specimen, Roger, Ark.

Ventrals 116. Caudals 40.

Tantilla gracilis Bd. and Girard.

Blue Mt. Station, Hartford (2), Ark.; South McAlester (5), Sugar Loaf Mt. (2), Limestone Gap (4), Wister, I. T., and New Braunfels, Tex.

Two of the largest have ventrals 117, 129; caudals 52, 41.

Agkistrodon contortrix (Linn.).

Sugar Loaf Mt. and Limestone Gap (2), I. T.

Ventrals 149, 150, 147. Caudals 42, 48, 45.

Crotalus horridus Linn.

Magazine Mt. and Petit Jean Mt., Ark.

Ventrals 173. Caudals 26.

Much lighter and more brightly marked than the average eastern specimens.

TEXAS REPTILES AND THEIR FAUNAL RELATIONS.

BY ARTHUR ERWIN BROWN.

THE REPTILES OF PECOS.

The town of Pecos, Texas, lies on the west bank of the river bearing the same name, at an elevation of about 2,800 feet. The high plain surrounding it and stretching west to the Rio Grande is much broken by irregular mountain ranges of considerably greater height.

The rainfall at Pecos does not exceed fifteen inches. The mean annual temperature is 60° Fahr., and the winter minimum about 18°.

During the past four years forty-eight species and subspecies of living reptiles have been sent to the Zoological Gardens by Mr. E. Meyenberg, of Pecos, all of which were collected in the neighborhood, with the exception of a few from the Davis Mountains, some fifty miles southwest. Many of these are little known and as I am aware of no published list of similar extent from this region, they are here enumerated.

CHELONIA.

Cinosternum flavescens (Agass.).

Platythyra flavescens Agass., Cont. Nat. Hist. of U. S., I, 430, Pl. V, figs. 12–15.

(?) *Cinosternum flavescens* Coues, Wheeler Survey W. of 100th Mer., p. 590, Pl. XVII.

Sufficient material is not available for full determination of the mud-turtles of the Mexican border, and identification of the present species must be made upon slight clues, for no published description of it exists beyond the mention of a few characters considered by Agassiz to be generic. These appear to apply to four turtles received in September, 1901, from Pecos. In addition, I have a similar one from El Paso, collected by Messrs. Townsend and Barber, and there is a sixth belonging to the Academy, collected at San Antonio, in 1903, by Dr. H. A. Pilsbry.

In form and scutellation these turtles approach *C. pennsylvanicum*. The El Paso specimen is 130 mm. in extreme length of shell and 97 in greatest breadth, a size rarely, if ever, reached by the eastern species. In adult males the shell is depressed on the dorsal line and shows traces

of a median keel, which does not appear in others, possibly female, of less dimensions. The small San Antonio example shows it slightly on the posterior declivity. The head is noticeably narrow and flat; jaws weak and beak feebly hooked. The feet are fully webbed and the fore-claws large and strong. There is a patch of keeled tubercles above the heel.

The large El Paso specimen, which is male, is uniform greenish-olive on the carapace, each shield having a narrow black border on its hinder margin, most marked on the costals. The plastron, which is concave and deeply striated, is yellow deepening to dark brown on the gulars and anals and on the bridge. The head and neck are entirely without markings, uniform dark gray above, whitish on the sides and beneath. Jaws yellowish with dark brown cutting edges. Outer surface of limbs dark gray without markings, lighter beneath. The largest Pecos specimen is 120 mm. long and is similar, except that the back is darker, the plastron decidedly green and less grooved. This is probably a female. The others are colored like the last, except one from Pecos 110 mm. long, which has the carapace brownish-yellow, with hardly a trace of green, and the dark margins to the shields hardly visible. The edge and under side of the marginals is dull orange. Plastron yellow, darker in front and behind.

Compared with Pl. XVII in the *Wheeler Survey*, to which the name *C. flavescens* is attached, all my specimens have the shell narrower and more regularly oval; the head and neck are noticeably flat and narrow, and the pectoral shields are nearly triangular and form an exceedingly short suture as in *pennsylvanicum*, instead of the wide one shown by the plate.

This species is nearly related to *pennsylvanicum*, but as far as present material goes, is amply distinguished by its form of head and by color characters.

Its geographical limits remain to be established. All the specimens I have seen are Texan.

Chrysemys mobilensis (Holbr.).
Chrysemys elegans (Wied.).
Terrapene ornata (Agass.).

LACERTILIA.

Crotaphytus collaris (Say).

Some of the Pecos specimens exhibit the double row of interorbitals attributed to *C. baileyi* Stej.[1] I have also a number of

[1] *No. Am. Fauna*, No. 3, p. 103, Pl. XII, fig. 1.

C. collaris from Seymour, Texas. In this series I find individuals with a single row of interorbitals, and those with them partly divided, to be each about two-fifths of the whole number, and those with a double row about one-fifth. In association with these differences I do not find any constant changes in the size of the supraoculars, in length of snout or breadth of head. The last two proportions vary with age, old examples having much broader heads. These Seymour specimens are about half-grown and were all collected together.

The chief character of *baileyi* we thus find far outside of the region assigned to it, in company with undoubted *collaris* and intermediates. Two *Crotaphytus* in the Academy's collection, taken by Rehn and Viereck in 1902, at Dry Cañon, New Mexico, and assigned by Mr. Stone[2] to *C. c. baileyi* are like the Pecos and Seymour examples with double interorbitals. If these specimens are *baileyi*, it occurs promiscuously among *collaris;* if they are not *baileyi*, then the chief character of that species occurs as a meaningless variation in *collaris*, leaving the former species to stand upon slight and indefinable differences which vary with age. In either case, the foundations of *baileyi* are not strengthened by their appearance.

Crotaphytus wislizeni B. & G.

Femoral pores in two specimens 18–22. Length of ♀ 324 mm. (tail 208). This specimen in June has on the sides vertical bands and spots of vermilion, which extend on the upper surface of the fore and hind limbs and the under side of the tail. The pale cross-bands have entirely disappeared from the body, but are distinct on another specimen 305 mm. long.

Holbrookia maculata Girard.

Five specimens belonging to the form considered by Cope to be *H. m. maculata*. Femoral pores in most cases 11 or 13; maximum 13, minimum 9.

Holbrookia texana (Trosch.).

Femoral pores usually 14–15; maximum in nineteen specimens 16, minimum 12; very inconspicuous in females. The hind leg may fall short of the eye or reach to the end of the snout. A ♂ in June, doubtless in full breeding color, is very striking, there being much orange on the shoulders, including the upper back, and on the forearms. The hinder part of the back and sides and upper surface of the hind legs are bright green, becoming yellowish on the tail. The jet-black lateral crescents are set in a patch of rich blue which does not meet its fellow

[2] *Proc. Acad. of Nat. Sci.*, 1903, p. 30.

on the abdomen. Under side of thigh pale blue; back of upper arm and front of forearm green.

In this species the postinfralabials below the angle of the jaw are usually in but one or two rows, but occasionally, as in the male above described, they are as numerous as in *H. maculata*.

Uta stansburiana B. & G.

Femoral pores in eighteen specimens 13–18. Greatest length 150 mm. (tail 93).

Uta ornata B. & G.

Femoral pores 12–16, usually about 13. Greatest length 130 mm. (tail 78).

The chief difference between *U. ornata* and *U. symmetrica* is said to be[3] that in the former the hind leg is usually shorter than the distance from the collar to the vent, while in the last it is longer. In nineteen *U. ornata* from Pecos and Seymour, I find that 3 ♂ and 1 ♀ have the hind leg longer than the distance stated; 4 ♂ and 1 ♀ have it equal and in 10 ♀ it is shorter.

Sceloporus spinosus clarkii B. & G.

Four specimens received in May, 1901, from Pecos (now Nos. 15,743-46 Academy collection) are referred to this subspecies. They have the hinder large supraoculars in contact with the parietals and fronto-parietals; the preauricular scales are broader than long; femoral pores 12–13; and an interrupted cervical collar.

The distinction between this form and *S. magister* is of doubtful validity, a specimen from Tucson, Arizona, now before me, which on its preauricular scales would be assigned by Mr. Stejneger to the last name, is less distinctly banded on the forearms than two of the Pecos specimens.

Sceloporus torquatus poinsetti B. & G.

Apparently very common.

Sceloporus consobrinus B. & G.

A large number of specimens are well distinguished from *S. undulatus* by color characters, as well as by the slight differences in scutellation pointed out by Cope.

Phrynosoma cornutum (Harl.).

Phrynosoma modestum Girard.

Cnemidophorus sexlineatus sexlineatus (L.).

Two from Pecos do not differ materially from eastern examples except in having coarser dorsal scales, but four others collected at Sey-

[3] Stejneger, *No. Am. Fauna*, No. 3, p. 107.

mour, Baylor county, in northern-central Texas, have similarly coarse scales, one has the collar-edge occupied by a row of granules, and in another the large scales of the collar are most distinct in the centre. The pale dorsal area shows a tendency to contract and take on the form of a median stripe. All these differences being in the direction of *C. perplexus*. These specimens are noticeable for their small number of femoral pores, which are in each 13–14; (2) 14–15; 15–16. The usual range in *sexlineatus* being 15–19.

Cnemidophorus sexlineatus perplexus B. & G.

I have a number of specimens from Pecos. Compared with *sexlineatus* most of them have a slightly longer snout, causing the loreal and sometimes the postnasal to be elongated. There are seven light stripes, the additional one being median and of the same width as the laterals. This replaces the light dorsal area of *sexlineatus*. Usually the light stripe on the back of the thigh is absent, but it is well marked in one young example 110 mm. long. The collar scales are less enlarged and occupy a somewhat triangular space in the centre, and the edge of the collar is usually formed by one or two rows of small granules, although two of my specimens have large scales on the edge. The gular tract of minute scales contrasts less strongly with those surrounding it, and the dorsal scales are coarser. According to Cope the femoral pores are 19, but in ten which I have examined they are 13–18, averaging 15. The hind leg may reach the axilla or the eye, but in most cases about touches the ear. One of my specimens has the anterior supraorbital separated from the next one by small granules. The largest is 222 mm. long (tail 158). The proportions are slender.

Prof. Cope regards this form as a subspecies of *tessellatus*, with which in general its scutellation agrees, though I find the number of femoral pores to be much less; but it does not appear to take on the spotted pattern of that species, and the fact that both *sexlineatus* and *perplexus* are striped at all ages and are more nearly equal in size and proportions, in connection with their disposition to intergrade where they come together in Texas, seems to indicate that they should be placed together as subspecies. In both of them a few of the postantebrachials are sometimes a little enlarged, but in no case that I have seen do they even approach the large scuta characteristic of *C. gularis*.

Cnemidophorus grahami B. & G.

This species is almost identical with *C. s. sexlineatus* in scale characters. The one specimen in the present collection has 21 femoral pores, which agrees with the number given by Cope. It has a freno-orbital

on one side. At present this rather rare form seems to be amply separated by color characters.

Cnemidophorus tessellatus (Say).

Two specimens of the color form noted by Cope as *C. t. tessellatus* were received in May, 1903. The largest measures 268 mm. (tail 178). They correspond closely with Cope's description, but one has the femoral pores 24, and the other 25, as against the maximum of 21 given by him. The brachials are in from four to seven rows. Both have round dark spots under the jaws, and in one the belly is tinged with orange. The hind leg reaches the eye or a little less.

A large series in the Academy's collection, secured by Messrs. Rehn and Viereck at Alamogordo, New Mexico, in 1902, shows no important variations from the Pecos specimens. Femoral pores 22–25, average of fifteen 23.

Cnemidophorus gularis B. & G.

Five examples from the Davis Mountains, south of Pecos, the largest of which measures 240 mm. (tail 142), have femoral pores 15–17; brachials in 4–5 rows; antebrachials 3–4; femorals 6; tibials 3. The hind limb is short, reaching only to the shoulder. There is a row of white spots in each dark stripe, but these do not merge into the light interspaces. There is a light dorsal area resembling but narrower than that of *C. s. sexlineatus*. Some examples in juvenile pattern much resemble that species in this respect, while in others the light area is represented by two narrow lines corresponding to its outer borders, but *gularis* may always be distinguished by the large scales under the forearm. Cope gives the femoral pores as 18–22, whereas, in a considerable series from Texas and New Mexico, I find but one with the number as great as Cope's minimum. They range from 15–18, with an average of 16.

While *sexlineatus* and *gularis* have doubtless had a common origin, the differentiation reached in adults is great, and I cannot regard the occasional retention of the earlier style of color marking by the young of *gularis* as true intergradation.

Eumeces obsoletus B. & G.

Three have been received from Pecos. I have also two from Seymour.

OPHIDIA.

Glauconia dulcis (B. & G.).

Eutænia proxima B. & G.

One specimen from Pecos measured 1,160 mm. (tail 280). This is the largest I have met with.

Eutænia sirtalis parietalis (Say).
Eutænia marciana B. & G.
Eutænia eques (Reuss).

Nineteen specimens, all from the Davis Mountains. The dorsal stripe is yellow, often more or less orange; the laterals pale greenish. Ventrals 151–174; subcaudals 64–86. Occasionally there are nine upper labials. One of these specimens 700 mm. long has a very short tail, only .17 of the length.

Tropidonotus clarkii (B. & G.).
Tropidonotus rhombifer Hallow.
Tropidonotus sipedon transversus Hallow.

All the specimens received were light in color, with the markings so obscure as to be distinct only in the young.

Salvadora grahami B. & G.
Zamenis flagellum flagellum (Shaw).

Most of this form from Pecos have been of large size and pale color. Some show more or less of the narrow cross-bands, as in *Z. f. frenatus;* some have wide cross-bands, as are seen at times in *Z. t. ornatus.*

Two large ones, about 1,700 mm. long, were buff on the back, with distinct wide dark cross-bands. Top of head and ventrals pink, with darker red spots on the throat.

Zamenis tæniatus ornatus (B. & G.).
Coluber emoryi (B. & G.).
Coluber obsoletus lindheimeri (B. & G.).
Coluber subocularis A. Brown.

Eight specimens of this species have been collected, as far as is known. In addition to the four on which the original description was based, two more were received at the Zoological Gardens in 1902, and the New York Zoological Society has also received two, one of which was courteously sent me after death by Mr. R. L. Ditmars. The three now in my possession have the scales in 33 rows, and the upper labials 10–11. All seem to have come from the Davis Mountains.

Pityophis catenifer sayi (Schl.).

Very common and reaches a large size; the largest measured 2,085 mm. in length, with a circumference of 210 mm.

Arizona elegans Kenn.

All the specimens are noticeably reddish or pink on the dorsal line, between the spots.

I have also received this species from Seymour, Texas, collected by Mr. F. M. Deaver.

Contia episcopa episcopa (Kenn.).

One received in April, 1902, has the loreal absent, the nasal reac[illegible]es the preocular on one side, and the prefrontal reaches the seco[illegible]nd labial on the other.

Diadophis amabilis B. & G.

One from the Davis Mountains, 530 mm. long, is light ash on t[illegible]the body including the outer row of scales; belly yellowish-salmon, b[illegible] be-coming blood-red under the tail, the ventrals heavily spotted wi[illegible]ith black. No nuchal collar.

Ophibolus getulus sayi (Holbr.).

Most of those received from Pecos are of the color pattern calle[illegible]ed *O. splendidus* B. and G., with unspotted tracts on the back. I hav[illegible]ve elsewhere[4] given reasons for refusing to recognize this color-form eve[illegible]en as a subspecies. In the latest note which I have seen, supporting it[illegible] its distinctness,[5] the author says: "It is true that western examples o[illegible] of what is usually called '*Ophibolus sayi*,' especially those from Arkansa[illegible]as and Indian Territory, approach the color pattern of *L. splendida;* bu[illegible]ut in the first place it is only an 'approach,' and in the second plac[illegible]ce they retain the normal number of 21 scale rows characteristic o[illegible] of the form which we have just named *L. holbrooki*" (=*O. g. sayi*)[illegible] Prof. Cope also says:[6] "I have not found any variation in the different[illegible] scale formulas of the two." The only comment to be made is that[illegible] these gentlemen can not have counted the scale rows in any large num-[illegible] ber of specimens. I have before me at this moment five living exam-[illegible] ples from Pecos, showing more than an "approach" to the pattern of [illegible] *splendidus*, one at least even having the head unspotted except on [illegible] the snout; three of these have 23 rows, and two have 21. The [illegible] case seems analogous to that of *Crotaphytus baileyi*, already discussed, [illegible] and does not strengthen the evidence for *splendidus*, unless selected [illegible] individuals with 21 rows and usually spotted heads are to be called [illegible] *O. g. sayi*, and those with 23 rows and usually unspotted heads are *O. splendidus*, even when they occur side by side—which would not com-mend itself as a conception of specific difference.

Ophibolus alternus A. Brown.

The type, from the Davis Mountains, is the only one known.

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[4] *Proc. Acad. Nat. Sci. Phila.*, 1901, p. 76

[5] L. Stejneger, *Proc. U. S. Nat. Mus.*, Vol. 25, p. 152 (1903).

[6] *Report U. S. Nat. Mus.*, 1898, p. 919.

Rhinochilus lecontii B. & G.

Heterodon nasicus B. & G.

Tantilla nigriceps Kenn.

The one specimen received had the ventral surface pinkish-salmon color in life.

Elaps fulvius (L.).

One specimen received.

Ancistrodon contortrix (L.).

One specimen received.

Crotalus atrox atrox B. & G.

Crotalus confluentus Say.

The Faunal Relations of Texas Reptiles.

An attempt to determine the elements composing the local fauna above noticed, has led to a study of the reptiles of the entire State of Texas, the result of which is, in my belief, to establish three facts, hitherto not wholly free from uncertainty: first, that the boundary between the Austroriparian and Sonoran reptilian faunas lies approximately between the ninety-sixth and the ninety-eighth meridians of longitude in Texas; second, that the restricted Texan district of Cope is not Austroriparian but Sonoran; third, that transcontinental zones of distribution can not be maintained in the Medicolumbian region for reptiles.

In his final essay upon the life regions of North America, determined mainly by a study of reptiles and batrachians, Prof. Cope[7] placed the portion of Texas extending from the high lands east of the Pecos river to a north and south line about the longitude of Austin, in his Texan district of the Austroriparian subregion, and the portion east of it, in the Louisianian district. Western Texas he attached to his Chihuahuan district of the Sonoran subregion, which included the higher portion of central and northern Mexico, and stretched west through southern New Mexico and Arizona to southern and Lower California. The great plains from northern Texas, east of the Rocky Mountains, excepting the east and west river bottoms, he called the Central district of the Sonoran.

Dr. C. Hart Merriam,[8] basing his conclusions chiefly upon the distribution of plants and mammals, established more or less parallel zones stretching completely across the continent from the Atlantic to the Pacific, the greater part of temperate North America being occupied

[7] *Rep. U. S. Nat. Mus.*, 1898, pp. 1199–1234.

[8] *Proc. Bio. Soc. of Wash.*, 1892, Vol. VII; and *Nat. Geog. Mag.*, 1894.

by the Upper and Lower Austral, each divided into a Humid district beginning at the Atlantic coast and merging insensibly into an Arid on the plains west of the Mississippi. The boundaries of his humid or Austroriparian division of the Lower Austral agree in the main with Cope's Austroriparian subregion, and the arid division, which he termed the Lower Sonoran, with Cope's Chihuahuan.

In Cope's view[9] the distribution of reptiles does not accord with the arrangement proposed by Merriam, for the reason that both in the east and the west, relationships in this class are much closer from south to north, than horizontally.

In the following examination, the term Austroriparian is used to denote the subregion so named by Cope, minus his Texan district. For present purposes I include in it his Floridan subregion. Sonoran is also used in Cope's sense.

I am able to find reliable records of the occurrence of one hundred and sixteen[10] species and subspecies of reptiles within the State of Texas, and by plotting all the localities of their collection known to me, upon a map, they arrange themselves into the following categories:

I.—Sonoran species, which appear to range little, if at all, east of longitude 96° in Texas:

A.—Chihuahuan:[11]

Cinosternum flavescens	*Sceloporus variabilis*
Testudo berlandieri	*scalaris*
Chrysemys ornata	*Phrynosoma cornutum* C.
Crotaphytus collaris C.B.	*modestum*
wislizeni B.	*Eublepharis variegatus*
Holbrookia texana	*Heloderma suspectum*
maculata C.	*Cnemidophorus tessellatus* B.P.
Uta stansburiana B.	*perplexus*
ornata	*gularis*
Sceloporus torquatus poinsetti	*Gerrhonotus liocephalus*
yarrovi	*Barissia imbricata*
ornatus	*Eumeces guttulatus*
spinosus clarkii	*obsoletus* C.
consobrinus C.	*Anniella texana*
couchi[12]	*Glauconia dulcis*

[9] *l. c.*, p. 1205.

[10] *Macrochelys lacertina*, *Chelydra serpentina* and *Eutænia radix* doubtless enter Texas, but I have no exact localities, and they are omitted here.

[11] The letters C. E. B. P. indicate that the species also enters the districts known respectively as Central, Eastern, Basin and Pacific.

[12] Taken at Devil's river, Tex., in 1903, by Prof. H. A. Pilsbry.

adophis regalis C.
menis tæniatus tæniatus B.P.
tæniatus ornatus
lvadora grahami
luber emoryi C.
bairdi
subocularis
rizona elegans
hinochilus lecontii
ohibolus doliatus annulatus
Ophibolus alternus
Contia episcopa isozona
Hypsiglena ochrorhyncha[13]
Tropidonotus sipedon transversus C.
Eutænia marciana
eques
Tantilla nigriceps C.
Crotalus molossus
atrox atrox
lepidus

B.—Central:

Terrapene ornata
Eumeces multivirgatus
Heterodon nasicus
Zamenis constrictor flaviventris B.P.
Pityophis catenifer sayi
Ophibolus calligaster wE.
Tropidoclonium lineatum wE.
Eutænia sirtalis parietalis B.P.
Sistrurus catenatus consors[14]
Crotalus confluentus

C.—Texan (restricted):

Aspidonectes emoryi
Crotaphytus reticulatus
Holbrookia propinqua
Lysopticus lateralis
Sceloporus thayeri
Cnemidophorus grahami
Eumeces pachyurus
tetragrammus
brevilineatus
Coluber obsoletus lindheimeri
Contia episcopa episcopa
taylori
Amphiardis inornatus

.—Chihuahuan and Central species, which extend east of longitude 96° (wA. or wE. indicates that the species barely enters the western part of the region):

Chrysemys elegans wA.
Sceloporus spinosus spinosus[15]
Diadophis amabilis wA.
Tropidonotus clarkii
Ophibolus getulus sayi wA. wE.
Eutænia proxima wA. wE.
Tantilla gracilis wA.

I.—Austroriparian species, which enter Texas but do not appear to extend west of longitude 98° (E. are also Eastern):

Alligator mississippiensis
Aspidonectes ferox
Tropidonotus sipedon fasciatus
grahami

[13] Received at the Zoological Gardens in 1903 from Seymour, Tex.
[14] =*Crotalophorus edwardsi* B. and G.
[15] =*Sceloporus floridanus* B. and G.

Aromochelys carinatus	*Storeria dekayi* E.
Terrapene carolina carolina E.	*occipitomaculata* E.
carolina triunguis	*Haldea striatula* E.
Testudo polyphemus	*Spilotes corais couperi*
Anolis principalis	*Heterodon platyrhinus* E.
Sceloporus undulatus E.	*Ophibolus doliatus doliatus* E.
Liolepisma laterale E.	*doliatus coccineus*
Ophisaurus ventralis	*Virginia elegans*
Eumeces quinquelineatus	*Sistrurus miliarius*
Eutænia sirtalis sirtalis E.	*Crotalus horridus* E.

Of the above, *Aromochelys carinatus*, *Tropidonotus grahami* and *Virginia elegans* are not known east of the Louisianian district.

IV.—Austroriparian species, which extend west of longitude 98° in Texas:

Chrysemys mobiliensis	*Ancistrodon piscivorus*
Zamenis flagellum flagellum	*Elaps fulvius*
Tropidonotus rhombifer	

To these are to be added *Cnemidophorus sexlineatus*, *Cyclophis æstivus*, *Liopeltis vernalis* and *Ancistrodon contortrix*, which are also Eastern and to some extent Central.

V.—Neotropical intrusions:

Drymobius margaritiferus	*Sibon septentrionale*
Erythrolamprus imperialis	

It is seen that seventy-three Sonoran species practically fail to range east of longitude 96° in Texas, while but seven pass eastward to any distance beyond that meridian, five of these entering the western part only of the Austroriparian, while the two others are exceedingly rare east of the Mississippi river.

Of species which belong to the Austroriparian and Eastern, twenty-four which enter Texas do not extend much beyond longitude 98°, while but nine pass beyond it into western Texas, and of these three are of aquatic habits and four more are widely ranging forms.

If anything is made clear, therefore, by a study of these lists, it is that the zone of change between the eastern and the western faunas is this north and south belt lying approximately between the 96th and 98th meridians. This area nearly coincides with that in which the heavy rainfall of the Gulf Coast drops to below thirty inches annually, and lies somewhat eastward of where the arid region may properly be said to begin, the line of twenty inches rainfall being just west of the

)0th meridian—a fact which suggests that species belonging to the ry plains fauna may endure a small addition of moisture better than iose from a moist region can withstand drought. In a general way is also the region where elevations of less than 1,000 feet begin the se which reaches to between 3,000 and 5,000 on the plateau borderig the Pecos river. Its western boundary is probably the beginning f what Cope terms "the first plateau."

The geographical limits of Cope's Texan district are nowhere clearly iarked out by him, and his views as to its affinities were subject to iange. In 1875[16] he says the Sonoran "occupies the lower valley f the Rio Grande, and extends into Texas as far as the desert east of ie Pecos." East of this lay his Texan district, without defined limits ı the east and south, which he assigns to the Austroriparian subregion. ı 1880[17] he speaks of the Texan district as Sonoran, and appears to onsider it as beginning on the west at about 3,000 feet elevation, its istern boundary running north and south near longitude 98° to ithin twenty miles of San Antonio, from whence it stretched west to ie Rio Grande. In 1896[18] he returned without comment to his ırlier opinion and put the Texan district back in the Austroriparian. It may be possible at present to reach a definite opinion as to its roper association.

If the Texan district be regarded as beginning at the debatable zone hich has been indicated here, between 98° and 96° longitude, and ctending south to the Rio Grande and west to the Pecos river, it found that the elements composing its reptilian fauna are the illowing:

onoran: Chihuahuan	39	
Central	8	
	—	47
'exan (restricted)		13
ustroriparian		5
)f wide range		4
		—
		69

As far as is now known several of its peculiar species, as *Holbrookia propinqua* and *Sceloporus thayeri*, range slightly to the south and west, outside of the boundaries here assigned to it, and may ultimately have o be regarded as Chihuahuan, but in the main they appear to be conined to these limits. A guide to its western boundary may be found

[16] *Bull. U. S. Nat. Mus.*, No. 1, p. 68.
[17] *Bull. U. S. Nat Mus.*, No. 17, p. 46.
[18] *American Naturalist*, November and December, 1896.

in the absence of the Chihuahuan species *Crotaphytus wislizeni, Uta stansburiana, Sceloporus spinosus clarkii, Cnemidophorus perplexus* and *Crotalus molossus*, none of which seem to range east of the Pecos.

This large number of peculiar species quite justifies the setting aside of a Texan district, but the overwhelming proportion of its Sonoran forms relegates it to that subregion, and not to the Austroriparian, with which it was finally associated by Cope.

The boundary thus determined between the Austroriparian and Sonoran subregions corresponds closely to that given by Merriam[19] to his Humid and Arid divisions of the Lower Austral, and it remains only to inquire into the reciprocal relations of the reptiles inhabiting these areas.

The Chihuahuan and Texan districts together share twenty-three species with the Central, while of the sixteen which they have in common with the Austroriparian, five (*Chrysemys elegans, Diadophis amabilis, Ophibolus getulus sayi, Eutænia proxima* and *Tantilla gracilis*) are also Central and only enter the western part of the Austroriparian. Four more (*Cnemidophorus sexlineatus, Cyclophis æstivus, Liopeltis vernalis* and *Ancistrodon contortrix*) are both Central and Eastern. But seven species are therefore left common to and restricted to the Sonoran and Austroriparian (*Chrysemys mobilensis, Sceloporus spinosus spinosus, Tropidonotus clarkii, Tropidonotus rhombifer, Zamenis flagellum flagellum, Elaps fulvius* and *Ancistrodon piscivorus*), and of these, four being aquatic are rendered in some degree independent of the laws governing the migration of land forms. So far as their species are concerned these two subregions have very little in common.

Turning now to the genera recorded from Texas, twenty-five, found in both subregions, are of such wide range in the Medicolumbian that they are without bearing on the present question and may be left out of consideration.

The following Sonoran genera do not enter the Austroriparian:

Crotaphytus C.B.	*Barissia*
Holbrookia C.	*Anniella*
Uta B.	*Glauconia*
Lysopticus	*Salvadora*
Phrynosoma C.B.	*Arizona*
Eublepharis	*Rhinochilus* C.
Heloderma	*Contia*
Gerrhonotus	*Hypsiglena* C.
	Amphiardis

[19] *Proc. Biol. Soc. of Wash.*, Vol VII, p. 28 and map.

Of Austroriparian genera these do not range into the Sonoran:[20]

Alligator N.	*Farancia*
Anolis N.	*Rhadinia* N.
Ophisaurus	*Stilosoma*
Rhineura N.	*Cemophora*
Spilotes N.	*Seminatrix*
Abastor	*Liodytes*

I do not know of a single truly Sonoran genus which extends into the Austroriparian which is not found in other subregions as well. No strictly Austroriparian genus extends into the Chihuahuan, and no genus is common to both areas which is not found elsewhere. So far as genera are concerned, the only bond of unity between the two halves of the Lower Austral (=Austroriparian+Texan and Chihuahuan of Cope) is that they alone in the Medicolumbian share *Testudo*, *Tantilla* and *Elaps*, all of which are Neotropical.

The Sonoran shares the following genera with the Central: *Crotaphytus*, *Holbrookia*, *Phrynosoma*, *Rhinochilus*, *Hypsiglena*.

It is clear, then, that the community in reptiles between the Sonoran and the Austroriparian is much less than that between the Sonoran and the Central; it is, in fact, limited to widely ranging genera.

While it is not intended to go into the details of distribution throughout North America, a few general observations must be stated, because of their bearing upon the present question.

The usual tests, such as differentiation, predominance in numbers, and genetic relationship, used in determining centres of distribution, all point among reptiles to the two southern centres in the Medicolumbian, to which attention has been directed by Prof. C. C. Adams,[21] the location of which corresponds to the southeastern Austroriparian and the Chihuahuan. The former gave rise to nearly all the aquatic turtles. It has supplied most of the widely ranging genera of snakes, some of which, as *Coluber*, *Zamenis* and *Tropidonotus*, as well as *Emys* among turtles, are found also in the Eurasian portion of the Holarctic. Its scarcity of lizards amounts to poverty. The reptiles of the Eastern subregion are almost wholly derived from this southeastern centre; no genus is peculiar to it, and but few species, especially east of the Alleghenies. The differences between its eastern and western portions are considerable, and in the Mississippi valley it shares a few snakes with the Central, some of which are Texan and Chihuahuan. Upon reptiles alone, the Eastern could hardly be maintained as a subregion apart from the Austroriparian and of equal rank.

[20] Those marked N. are Neotropical.
[21] *Biol. Bull.*, Vol. III, p. 121 (1902)

The Chihuahuan has given origin to no widely ranging snakes except *Crotalus* and *Sistrurus*. Its great wealth of lizards has not spread extensively into the Atlantic slope. *Sceloporus* and *Cnemidophorus* being represented there by but one species each; *Eumeces* by one which reaches to Canada and perhaps two others more southern and scarce in numbers; and the one species of *Liolepisma*, reaching to New Jersey.

That the Austroriparian fauna is the older of the two is made probable by the geological age of the region, and certain by the character of its forms, many of which belong to genera widely spread in the Holarctic, others having obvious genetic relationship to these or to other ancient forms. The separate identity of these two faunas, as far back as they can be traced, confirms the conclusion already reached from their present distribution, that the association of the Sonoran with the Austroriparian into one transcontinental zone is unnatural and cannot be maintained for reptiles.

How far the stations occupied by reptiles conform to Dr. Merriam's vertical zones, when the attempt is made to correlate these in widely distant localities, can not now be determined. At a later time I hope to examine this branch of the subject in some detail, but even with the limited amount of information now available of the kind needed, certain anomalies appear which do not seem open to explanation by that theory.

Indeed the proposition that all forms of life must conform to the same areas of distribution accords with neither theory nor facts. It may be, as stated by the distinguished author of transcontinental life zones,[22] and doubtless is, illogical to assume that a faunal and a floral map must differ; but it is quite otherwise to assume as a working hypothesis that they may do so, and when organisms differ as widely in physiological adaptations as reptiles, for instance, do from mammals, the assumption that their reactions to the same conditions of environment must be similar, certainly is not far from likeness to a well-known logical fallacy.

While there can be no doubt of the controlling influence of temperature upon the distribution of reptiles as a class, it is quite certain that moisture plays a more important part in regulating the range of its genera and species than is the case with either mammals or birds, especially when their limited powers of migration are considered.

The details of their distribution in the southern divisions of the Medicolumbian sufficiently show its potency.

[22] *No. Am. Fauna*, No. 3, p. 27.

BEES OF THE GENUS NOMADA FROM CALIFORNIA.

BY T. D. A. COCKERELL.

TABLE OF SPECIES.

Males.

Legs black and yellow; abdomen yellow-banded, ... 1.
Legs red or reddish, or black and red; apex of abdomen usually emarginate, ... 7.
1. Apex of abdomen emarginate, ... 2.
Apex of abdomen entire; large species, ... 4.
2. Size large, over 11 mm. long, ... *excurrens*, Ckll.
Size smaller, hardly or under 9 mm., ... 3.
3. Lateral face-marks narrow, gradually tapering to a point; a yellow spot at top of eye, ... *decempunctata*, Ckll.
Lateral face-marks ending abruptly at level of antennæ; no yellow spot at top of eye, ... *sanctæcrucis*, Ckll.
Lateral face-marks obliquely cut off above, with a projection pointing toward antennæ, ... *subsimilis*, Ckll.
4. Scutellum black; anterior femora expanded into a large flat lamina, *hesperia*, Ckll.
Scutellum largely yellow; anterior femora ordinary, . . . 5.
5. Lateral face-marks obliquely truncate above; a large black area between them and supraclypeal mark, . . *edwardsii*, Cresson.
Lateral face-marks semilunar; a narrower black area between them and supraclypeal mark, ... 6.
6. Smaller, hind femora entirely black behind, *edwardsii australior*, Ckll.
Larger, hind femora yellow at apex behind, . . *hemphilli*, Ckll.
7. Tegulæ yellow; scutellum largely yellow; scape swollen, yellow in front; joint 3 much shorter than 4, ... *pascoensis*, Ckll.
Tegulæ not or hardly yellow (dull yellow in *coquilletti*); scutellum usually black, ... 8.
8. Abdomen red or reddish, with lateral yellow spots, but no bands; apex emarginate; scutellum black; mandibles simple, . . 9.
Abdomen more or less banded, ... 11.
9. Larger; first abdominal segment black only at extreme base; abdomen bright red, ... *subvicinalis*, Ckll.
Smaller; more than basal half of first abdominal segment black; abdomen dull colored, ... 10.
10. Second submarginal cell nearly square, third narrowed almost to a point, ... *bifurcata*, Ckll.
Second submarginal cell high and narrow, third about as broad above as second, ... *oregonica*, Ckll.

11. Larger; second submarginal cell very broad below, and narrowed almost to a point above, so that the lower inner angle is very acute; tegulæ dull yellow, ... *coquilletti*, Ckll.
    Smaller; second submarginal cell ordinary; basal nervure meeting transverso-medial, or slightly basad of it, ... 12.
12. First abdominal segment dark brown above, with a few light dots; apex entire; scape entirely dark, ... *subgracilis*, Ckll.
    First abdominal segment with a distinct light (yellow or reddish) band, ... 13.
13. Abdominal bands (except first) continuously light yellow; scape yellow in front; apex of abdomen emarginate, *subangusta*, Ckll.
    Abdominal bands ferruginous centrally on middle segments, yellow laterally; scape yellow in front,
    rhodosoma, Ckll. (and other males?).

Females.

Large species with yellow-banded abdomen, and bright ferruginous hair on thorax, ... *rhodotricha*, Ckll.
Not so colored, and usually much smaller, ... 1.

1. Abdomen black, with continuous light bands on the first two segments at least, or the black reduced to bands; a light spot before each upper corner of scutellum, ... 2.
   Abdomen red, without entire bands on first two segments, if any, 4.
2. Mesothorax partly red; scutellum red; abdominal bands white,
   crotchii nigrior, Ckll.
   Mesothorax black, ... 3.
3. Larger; metathorax with large light patches, . . *ashmeadi*, Ckll.
   Smaller; metathorax without light patches, . *formula*, Viereck.
4. Scutellum black, size small, ... 5.
   Scutellum red, size mostly larger, ... 6.
5. Basal nervure ending a little before transverso-medial, almost joining it; size a little larger; abdomen with interrupted yellowish-white bands, those on segments 3 and 4 deeply notched in front,
   marginella, Ckll.
   Basal nervure ending a little beyond transverso-medial; abdomen red without light bands, except two whitish spots or a band on fifth segment; apical part of abdomen suffused with black,
   elegantula, Ckll.
6. Abdomen with large yellowish-white markings, pointed mesad on segments 1 to 3, forming entire bands on 4 and 5,
   davidsoni, Ckll.
   Abdomen without such markings; basal nervure ending basad of transverso-medial, or rarely joining it, ... 7.
7. Base of first abdominal segment black right across; abdomen with a purplish luster; segments 2 to 5 with lateral cream-colored spots, ... *angelarum*, Ckll.
   Base of first abdominal segment not black right across, or without black, ... 8.

8. First abdominal segment with a large black triangular mark in the middle; abdomen without light spots; mandibles simple, *tintinnabulum*, Ckll.
   First abdominal segment not so marked. . . . . 9.
9. Face and front without black; at most a faint blackish stain above the antennæ, ... 10.
   Front with a great deal of black; mesothorax with a median black band, ... 14.
10. Third antennal joint hardly half length of fourth: anterior coxæ simple, ... *erythræa*, D. T.
    Third antennal joint over half length of fourth, ... 11.
11. Abdomen with small lateral cream-colored spots; second and third submarginal cells much narrowed above, . . *ultimella*, Ckll.
    Abdomen without such spots; second submarginal cell broader above, ... 12.
12. Length about 10 mm.; hind femora with a black stripe behind, *rubrica*, Prov.
    Length 8 mm. or less; hind femora with at most a black suffusion, ... 13.
13. Scape with conspicuous long dark hairs; mesothorax with a median black stripe, ... *californiæ*, Ckll.
    Scape without such hairs; mesothorax without a median black stripe, ... *rhodosoma*, Ckll.
14. Length at least 10 mm.; metathorax black with two red spots; hind femora with no black stripe behind,. . *excellens*, Ckll.
    Length 8 to nearly 9 mm.; metathorax, seen from above, red with a median black band, ... 15.
15. Hind femora with much black behind; scape with dark hairs; a red spot in front of middle ocellus, ... *latifrons*, Ckll.
    Hind femora red behind; scape without dark hairs; no red spot in front of middle ocellus, ... *atrofrontata*, Ckll.

Descriptions and Notes.

Nomada (Holonomada) hemphilli, sp. n.

♂.—Length 12–13 mm.; black and yellow. Allied to *N. superba* and *N. edwardsii*, resembling the latter by the black and yellow (instead of red and yellow) legs, and the former by the absence of yellow spots on the metathorax. It differs from *N. edwardsii* also as follows: Lateral face-marks broader above, with much black between them and the supraclypeal mark; flagellum paler beneath; yellow patch on scutellum large and entire (in *edwardsii* divided into two spots or patches); abdomen with less black above, the bands on second and third segments not or hardly contracted in the middle; a minute yellow spot present at summits of eyes; legs with a more orange-yellow color, and with less black, the anterior and middle femora yellow with a black patch above, hind femora black above except apically, anterior and

middle tibia wholly yellow, posterior tibiæ yellow with a small black stripe behind, all the tarsi yellow. The second and third submarginal cells are considerably contracted above, and the basal nervure ends only slightly basad of the transverso-medial. The postscutellum has a short yellow stripe.

Hab.—Three males labelled "So. Cal." (Coll. Acad. Nat. Sci. Phil.). Named after Mr. Hemphill, the well-known naturalist of San Diego, Cal.

Nomada (Holonomada) excurrens, sp. n.

♂.—Length about 12 mm.; black and yellow. Similar to *N. hemphilli*, except that the apical plate of the abdomen is broader and *strongly notched* (in *hemphilli* it is quite entire), and the transverso-medial nervure is strongly oblique (only slightly so in *hemphilli*). The hind tibiæ are entirely yellow, without the black stripe seen in *hemphilli*.

Hab.—"So. Cal.," one (Coll. Acad. Nat. Sci. Phila.). This is so close to *N. hemphilli* that it may prove to be only a variety; yet it has characters which would exclude it from *Holonomada*, as that group is defined by Robertson.

Nomada (Holonomada) edwardsii, Cresson.

Hab.—Santa Clara county, Cal. (*Coquillett*). In Coll. U. S. Nat. Museum.

Nomada (Holonomada) edwardsii var. australior, v. nov.

♂.—Length 11 mm.; black and yellow. Differs from *edwardsii* by its smaller size; supraclypeal mark larger (broader than long); lateral face-marks convex on the inner side and pointed above (concave on inner side above clypeus, and obliquely truncate above, in *edwardsii*); third antennal joint shorter, and paler beneath; ventral surface of abdomen wholly yellow beyond the second segment. The apical plate is entire, and the metathorax has a pair of yellow spots. From *N. citrina* it differs thus: Posterior orbits only very narrowly yellow, and that little more than half-way up; no yellow spot below middle ocellus; flagellum black above, dull red beneath; third antennal joint a little longer than fourth, the two together a little shorter than scape, etc. The hind femora are practically all black behind, and all the tibiæ have much black behind.

Hab.—Los Angeles county, Cal. (*Coquillett*). In Coll. U. S. Nat. Museum. Perhaps a distinct species.

Nomada (Holonomada) rhodotricha, sp. n.

♀.—Length about 13 mm., build of *N. superba;* black and red, abdomen with broad chrome-yellow or orange bands. Head and

orax very densely punctured, abundantly clothed with pale ferrugi-us hair; face broad; occiput and front (except a red patch below ddle ocellus) black; face up to level of antennæ (except narrow edges supraclypeal mark and line half-way down edge of clypeus) red, the l lateral face-marks continuing above very broadly until a point out level with end of scape, where they are much narrowed and tched, thence continuing over eyes, and suddenly broadening to m a broad postorbital red band; antennæ red, apical half of fla-llum dusky above; third joint conspicuously longer than fourth; per margin of prothorax, very narrow lateral margins of mesothorax, itellum, postscutellum, metathorax except narrow lateral margins d basal enclosure connecting with a smaller apical triangle, tubercles, gulæ and nearly all of pleura, all red; legs bright red; basal joint of id tarsi long and broad, and slightly dusky; wings reddish, nervures rk brown, stigma ferruginous; third submarginal cell much con-icted above; basal nervure ending very slightly basad of transverso-edial, the latter very slightly oblique; abdomen ornamented nearly in *N. superba*, but the yellow is orange, and the fifth segment is thout black; ventral surface orange with three black bands.

Hab.—"So. Cal.," four in Coll. Acad. Nat. Sci. Phila. A very dis-ict and beautiful species.

mada (Holonomada) hesperia, sp. n.

♂.—Length about 10 mm.; black and yellow. Head and thorax ickly clothed with white hair, very dull above, clear and shining neath, dense and silvery over clypeus; eyes pale green, converging low; basal half of mandibles, labrum, clypeus and broad lateral ce-marks (irregularly notched on inner margin above clypeus, and ding abruptly at about level of antennæ), all yellow; no supraclypeal ark; scape thick but not swollen, yellow beneath and black above; gellum black above and dull reddish beneath (third antennal joint llow beneath); joint 3 slightly longer than 4; thorax black with a llow spot on tubercles, but no other yellow; tegulæ lemon-yellow; ngs clear, nervures dull ferruginous; second and third submarginal lls greatly contracted above; basal nervure ending some distance isad of transverso-medial; legs yellow in front, largely black behind, pecially the hind legs; first joint of anterior and middle tarsi all llow; *anterior femora expanded below into a large yellow lamina, which convex anteriorly;* abdomen black with five continuous greenish-llow bands, that on second segment only moderately narrowed in ie middle; apical plate dark, entire; ventral surface yellow stained ith green, without much black except at base.

Hab.—"So. Cal.," two in Coll. Acad. Nat. Sci. Phila. Very distinct by the character of the anterior femora. Aside from this, the entirely black pleura and absence of supraclypeal mark distinguish it from *N. rivalis*, *N. suda*, *N. vincta*, etc.

Nomada (Micronomada) formula, Viereck.

Hab.—San Pedro, Cal., July 11 (*Cockerell*). This has the second submarginal cell as in Robertson's genus *Cephen*, but I cannot separate the latter from *Micronomada*. *N. flavipes*, Prov. appears from the description to be near to *N. formula*, but not identical.

Nomada (Xanthidium) crotchii var. nigrior, n. var.

♀.—Length about 9 mm.; the dark markings of abdomen black (not ferruginous), sharply contrasting with the creamy-white bands; hind margins of segments narrowly subhyaline and pale brown; metathorax black without spots. Basal nervure meeting transverso-medial, or very slightly basad of it.

Hab.—"So. Cal.," five in Coll. Acad. Nat. Sci. Phila.

Nomada (Xanthidium) pascoensis, sp. n.

♂.—Length about 8 mm.; yellow and black. Head and thorax very densely punctured, hoary with white hair, which is dense on the face, but not so as to hide the surface; basal part of mandibles, labrum, clypeus (except a sutural spot) on each side, supraclypeal mark, lateral face-marks and a flame-like mark beneath eyes, lemon-yellow; the lateral face-marks fill in the whole space between the clypeus and the eyes, but level with the supraclypeal mark suddenly narrow, and continue along the orbital margin as a rather broad band which ends (slightly swollen) at the level of the antennæ; thus the lateral face-marks above present some resemblance in outline to the head of a human femur; eyes green; *scape much swollen*, yellow in front and black behind; flagellum reddish-orange, the basal joints largely black above, *apical joint long and pointed;* third antennal joint triangular, about half as long as fourth, joints beyond oblique, 5 to 7 or 8 with minute denticles; flagellum crenulated; subtriangular patch on anterior part of pleura, upper margin of prothorax, tubercles, tegulæ, scutellum except margin, a small spot before each anterior corner of scutellum, and band on postscutellum, all lemon-yellow; metathorax all black; wings moderately dusky, stigma ferruginous; basal nervure almost meeting transverso-medial, a mere fraction basad of it; second submarginal cell quadrate; legs red; basal part of first four femora beneath, hind femora behind except apically, a suffused patch on hind tibiæ behind, and all the coxæ, black; knees, anterior legs in front (more or

less), middle tibiæ at apex, first joint of middle tarsi in front, and hind tibiæ at apex, yellow; abdomen closely and minutely punctured, lemon yellow, the segments black at base and more or less ferruginous apically; first segment with the basal half black, the apical half (except the hind margin) ferruginous centrally, with a yellow patch on each side; apical plate ferruginous, notched; venter black at base, otherwise varied with yellow and red.

Var. *a*.—Somewhat smaller; no light spots at anterior corners of scutellum.

Hab.—Pasco, Washington State, May 25, 1896 (*Trevor Kincaid*). Var. *a*, Los Angeles county, Cal. (*Coquillett*); in U. S. Nat. Museum. The front coxæ exhibit a very small spine, showing some affinity to Robertson's genus *Centrias;* but the insect is best referred to *Xanthidium*, near to *N. luteoloides*.

Nomada (Xanthidium) decempunctata, sp. n.

♂.—Length about 8 mm., rather slender, not very hairy (white hair on face, cheeks and sides of thorax), black and yellow. Eyes pale green; inner orbital margin presenting a double curve; mandibles except tips, labrum, clypeus, supraclypeal mark, lateral face-marks (rapidly narrowing from clypeus and ending in a sharp point on orbital margin at about level of antennæ), stripe at top of eyes, and stripe beneath eyes extending half-way up cheeks, all yellow; scape swollen, but not excessively so, yellow in front, black behind; flagellum ordinary, dull reddish beneath, black above, last joint obtuse; third antennal joint conspicuously shorter than fourth; mesothorax extremely densely punctured, nearly bare of pubescence; upper border of prothorax, tubercles, narrow marginal stripe at sides of mesothorax, elongate spot between tegulæ and scutellum, scutellum except margins, stripe on postscutellum, two round spots sublaterally on metathoracic enclosure, large subquadrate patches on metathorax, somewhat diamond-shaped spot behind tubercles, very large patch extending across pleura, and tegulæ, all lemon-yellow; legs yellow; coxæ black behind; hind femora black behind except at apex; anterior and middle femora, and all the tibiæ, with a black stripe behind, that on hind tibiæ covering nearly the whole surface, that on middle femora double (a broad and narrow stripe running parallel); middle and hind tarsi mostly black behind; wings fairly clear, dusky at apex, nervures and stigma dark brown; stigma large; second submarginal cell very narrow, higher than broad, receiving the first recurrent nervure at its middle; first submarginal cell considerably larger and longer than the other two combined; third greatly narrowed above; basal nervure ending well basad of the transverso-

medial; abdomen dull, not appreciably punctured, but very minutely roughened; apical margins of segments subhyaline brownish, this broader in the middle than at the sides; basal half of first segment black, the other half (except the margin) yellow, but the black sends a straight narrow band into the yellow in the middle line, extending about three-fifths the breadth of the yellow; there is also a sublateral small black spot on the yellow on each side near the hind margin, the same being repeated also on segments 2 to 5, which are similarly ornamented with yellow, except that the black invades it more in the middle line, the yellow on segments 2 to 4 being interrupted in the middle line; on segment 2 the black also sends a short tongue into the yellow at the sides; this description does not well indicate the complicated pattern, but it may be added that if the abdomen is viewed with the apex directed upward, the yellow on segments 2 to 4 has on each side a recognizable resemblance to the head of a bird; apical plate dark brown, deeply bifid; venter yellow, first segment with longitudinal black bands, third and fourth segments black at base; mesosternum with a large yellow patch.

Hab.—"So. Cal.," one in Coll. Acad. Nat. Sci. Phila. A very distinct species.

Nomada (Xanthidium) sanctæcrucis, sp. n.

♂.—Length about 8 mm.; rather slender, black and yellow. Head and thorax with little hair; facial quadrangle about square; mandibles except apex, labrum, clypeus, supraclypeal mark, lateral face-marks (rather broad, ending obtusely at level of antennæ), and stripe under eye extending about half-way up posterior orbits, all lemon-yellow; the black between the supraclypeal and lateral marks is broad, and sends a narrow tongue half-way down sides of clypeus; scape moderately swollen, yellow in front, black behind; flagellum long, ferruginous beneath, blackish above, ordinary in structure; third antennal joint about half length of fourth; mesothorax entirely black, coarsely and very densely punctured; upper border of prothorax, tubercles (except black dot), tegulæ, irregular (with a point directed upward and a longer one posteriorly) transverse patch on pleura, and two large spots on scutellum, deep yellow; postscutellum and metathorax entirely black; legs yellow, coxæ mostly black, femora black above except at apex; the first four femora, seen from behind, are longitudinally divided into black and yellow areas, but the hind femora are all black behind except at apex; anterior and middle tibiæ stained with blackish behind, hind tibiæ very dark brown behind except narrow upper border; middle and hind tarsi largely suffused with brown; wings brown-

ı, nervures dark brown, stigma ferruginous; second submarginal cell oderately, third greatly, narrowed above; transverso-medial nervure little basad of basal; abdomen banded with black and yellow; yellow and on first segment constricted but not divided in the middle; bands ı second and third segments narrower in the middle than at the sides, ut not abruptly constricted like that on first; bands on fourth and fth segments broad throughout, not narrowed in middle; sixth segent all yellow; apical plate dark brown, notched; venter yellow, with ie bases of the segments black; first ventral segment dark with a ellow mark shaped something a sheep's skull.

Hab.—Santa Cruz Mts., Cal. (U. S. Nat. Museum).

omada (Xanthidium) subsimilis, sp. n. (**civilis,** subsp.?).

♂.—Length 8½ mm., black and yellow, head and thorax thickly lothed with long erect coarse hair, yellowish-white below, brown above; ape also hairy. Tegulæ yellow; nervures and stigma ferruginous; asal nervure a little basad of transverso-medial; metathorax and utellums entirely black; basal area of metathorax with minute longiıdinal ridges; tibiæ yellow, each with a black spot behind, femora with black stripe behind. In all respects very closely related to *N. civilis*, om Cresson's description of which it differs thus: Supraclypeal mark ell developed; flagellum mostly black above; anterior margin of ellow band on first segment straight. These characters are not very nportant ones, but I have *N. civilis* from Colorado, and am confident ıat the Californian species is distinct, though it may prove that it ıould rank only as a subspecies. The dark hair on the thorax of *ıbsimilis* is a good distinguishing character.

Hab.—Los Angeles county, Cal., February (*Coquillett*). In U. S. at. Museum. Two specimens.

omada (Xanthidium) coquilletti, sp. n.

♂.—Length about 9 mm., rather slender, black and yellow, legs red ith some yellowish and black. Head and thorax with abundant rownish-white hair, dense and silvery on middle of clypeus and supraypeal area; eyes brownish-gray; facial quadrangle nearly square, a ttle narrowed below; basal part of mandibles, labrum, clypeus, stripe eneath eyes, and narrow lateral face-marks extending to level of ıtennæ, pale yellow; scape swollen, hairy, yellow in front and black ehind; flagellum ordinary, bright ferruginous, the three basal joints lack above; third antennal joint conspicuously shorter than fourth; ıorax dull and very densely punctured, a stripe on upper margin of rothorax, tubercles, flame-like mark (very not large) on pleura, and egulæ, dull yellow; no yellow on metathorax or scutellums; legs pale

red, knees and anterior femora in front pale yellow; anterior femora with a black spot at base behind, the other femora largely black behind; wings tinged brownish, stigma dark red; second submarginal cell triangular, very broad below, greatly narrowed above, third submarginal cell narrowed about half above; basal nervure ending distinctly basad of transverso-medial; abdomen with yellow bands; bases of the segments black, apical margins of the first four broadly ferruginous; on the third and fourth segments laterally are obscurely indicated lateral spots next to the ferruginous; yellow on first segment abruptly cut in the middle by black, that on the second segment greatly narrowed by a ferruginous backwardly projecting tongue; apical plate slightly notched; venter red (even to base) speckled with yellow, the yellow forming a curious pattern on the third segment.

Hab.—Santa Clara county, Cal. (*Coquillett*). In U. S. Nat. Museum. It is a little uncertain whether this is a *Xanthidium* or a *Nomada* s. str. It resembles *N. modocorum*, Ckll., from Oregon, but is easily distinguished by its much narrower, more parallel-sided abdomen, and the second submarginal cell as described.

Nomada (Xanthidium) ashmeadi, sp. n.

♀.—Length 10 mm.; black and yellow, not very hairy. Eyes sage-green; face a little broader than long; basal half of mandibles, labrum, clypeus, supraclypeal mark (more than twice as broad as long), lateral face-marks, wedge-shaped mark at top of eyes, and narrow posterior orbits almost up to wedge-shaped mark, all deep yellow; lateral face-marks very broad, their upper margin extending from upper lateral corner of supraclypeal mark obliquely upward (touching antennal socket) to a narrow truncation on the orbital margin about half-way between level of antennæ and top of eye; a fine black line passes down side of supraclypeal mark and upper half of clypeus, ending in a black circle looking like a minute ocellus; antennæ stout; scape not swollen, yellow suffused with red in front, black behind; flagellum deep red, first segment with a black basal spot above, last blackish above; third antennal joint about three-quarters length of fourth; thorax coarsely and very densely punctured; upper border of prothorax, tubercles (which are conical-protuberant), tegulæ (except an orange-red spot), almost whole pleura, spot before each anterior corner of scutellum, two large patches on scutellum joined posteriorly, postscutellum, *two round spots on metathoracic enclosure*, two large patches and lateral spots on metathorax, all deep yellow; legs yellow; coxæ mostly black behind; first four femora with a black stripe behind; hind femora black behind except narrow border and broad apex; tibiæ striped with black

behind; basal joint of hind tarsi with a suffused black stripe behind; small joints of tarsi more or less reddish; wings strongly yellowish-smoky, nervures fuscous, stigma ferruginous; second submarginal cell quadrate, receiving the recurrent nervure at its middle; basal nervure meeting transverso-medial; abdomen rather broad, yellow, minutely roughened; basal half of first segment (a little produced in middle line), and broad bases of second and third segments, jet black; venter yellow, second segment, and a reversed V on first, black.

Hab.—Los Angeles county, Cal. (*Coquillett*). In U. S. Nat. Museum. Named after the well-known hymenopterist of that institution. The spots on the metathoracic enclosure suggest *N. decempunctata*, but that is smaller and has a different venation.

Nomada (Phor) subgracilis, sp. n.

♂.—Length about 5 mm.; head and thorax densely punctured, with white hair; eyes gray; mandibles except tips, labrum, rather broad anterior margin of clypeus, and triangular lateral face-marks (coming to a very fine point somewhat below level of antennæ), all pale yellow; scape rather stout, dark reddish-brown, roughened, hairy; flagellum pale ferruginous beneath, black or nearly so above, apical margins of basal joints projecting above; third antennal joint about or slightly over half length of fourth; thorax black with a pallid spot on tubercles, but no other light markings; tegulæ dark red, punctured; legs dark brown, the first four yellow in front; wings dusky at apex, stigma reddish; marginal cell long; second submarginal little narrowed above, and receiving the recurrent nervure at its middle; basal nervure ending some distance basad of transverso-medial; abdomen finely rugoso-punctate, dark brown; first segment with an oblique pallid stripe on each side, and an obscure spot mesad of each; second to fifth segments with more or less interrupted bands, which are broadened and pale yellow laterally, but narrow and become suffused with reddish toward the middle; on the third to fifth segments these bands are interrupted sublaterally by large dark brown spots; sixth segment with a pale yellow entire band failing laterally; apical plate large, entire, with a distinct rim; venter brown.

Hab.—"Cala.," one in Coll. Acad. Nat. Sci. Phila. Mr. Viereck tells me it was confused with *N. gracilis* (from which it differs in venation) in the collection.

The remaining species are referred to the restricted genus *Nomada*, as understood by Robertson. I have not seen any species of *Gnathias* from California.

Nomada rubrica, Provancher, var. *a*.

♀.—A black stripe connecting the ocelli; hind femora with a black stripe behind. Wings strongly yellowish-smoky, basal nervure meeting transverso-medial, but rather on the basad side. Third antennal joint shorter than fourth. From *N. grayi*, Ckll., it is easily known by the venation, and absence of black on the cheeks.

Hab.—Los Angeles county, Cal. (*Coquillett*). In U. S. Nat. Museum.

Nomada subangusta, sp. n.

♂.—Length about 8 mm.; black, ferruginous and yellow; head and thorax with rather copious hair, dull brownish above, white below. Basal two-thirds of mandibles, labrum, clypeus, and lower corners of face, sending a line ending very sharply about half-way up orbital margin, all yellow; a narrow yellow stripe on lower third of posterior orbits; scape yellow (suffused with red basally) in front and sides, black behind; flagellum orange-ferruginous, more or less blackened above, especially the basal half; third antennal joint conspicuously shorter than fourth; thorax densely punctured, black, tubercles pallid, but no other pale markings; tegulæ ferruginous, hairy and punctured; legs ferruginous; anterior femora suffused with yellowish in front, and with a black stripe behind; middle femora black beneath except at apex; hind femora black behind and beneath except at apex, but the margins of the black suffused; anterior and middle tibiæ with a suffused blackish spot; wings clear, dusky on apical margin, nervures fuscous, stigma ferruginous; second submarginal cell narrow, higher than long; basal nervure ending just basad of transverso-medial; abdomen with the basal half of first segment, and the bases of following segments more or less (but edged with ferruginous) black; apical margins of the segments very broadly ferruginous; bands pale yellow, that on first segment abruptly interrupted; that on second gradually narrowed to middle but not quite interrupted; apical plate rather long and narrow, deeply notched; shape of first segment long and narrow; venter ferruginous variegated with pale yellow.

Hab.—"So. Cal.," one from the W. J. Fox collection (U. S. Nat. Museum). Close to *N. modocorum*, Ckll., with which it nearly agrees in markings, color and pubescence; but it is a much narrower insect, especially in the first abdominal segment, than *modocorum*. It differs in the same manner from *N. ruficornis*, L., which it also much resembles. By the narrow first abdominal segment, and other characters, it resembles *N. cordleyi*, Ckll., but the latter has a much longer flagellum, and the abdomen is narrower in the middle.

Nomada erythræa, Dalla Torre.

♀.—Closely allied to *N. ultima,* Ckll.; mandibles and anterior coxæ simple; stigma orange-brown; mesothorax and metathorax red without markings; second, third and fourth abdominal segments with successively smaller pallid lateral spots, easily overlooked; basal joint of hind tarsi with dark hair on inner side. The basal nervure ends just basad of the transverso-medial.

Hab.—San Bernardino county, Cal., May. One in U. S. Nat. Museum.

Nomada rhodosoma, sp. n.

♀.—Length 7 mm. Almost exactly like *N. erythræa,* but a little smaller, and the third antennal joint almost or quite as long as the fourth (in *erythræa* it is not over half as long). There is black between the ocelli, and a black stain in the middle of the metathoracic enclosure. Basal nervure ending scarcely basad of transverso-medial. Stigma ferruginous. Hind tibiæ strongly tuberculate on the outer edge, which is not the case in *erythræa.*

Hab.—Santa Cruz Mts., Cal., two in U. S. Nat. Museum. Six males (four from Santa Cruz Mts., two from "Cala.") are provisionally assigned here; they may not all belong to one species.

Nomada californiæ, sp. n.

♀.—Length about 7½ mm.; also similar to *erythræa,* but easily distinguished by the characters given in the table. The head is very broad, and the upper parts of the head and thorax are conspicuously clothed with dark hairs, while the hair on the sides and under parts is white. Ocelli on a black patch; mesothorax with a blackish band; metathorax with a blackish band, becoming faint anteriorly; postscutellum with a decided yellow tint; abdomen without black; antennæ entirely red; third joint almost as long as fourth; wings rather dusky, not very dark at apex; stigma orange-ferruginous; basal nervure ending a short distance basad of transverso-medial; legs red with no black marks except on coxæ; the hind femora have a very faint blackish stripe behind.

Hab.—"So. Cal.," one in Coll. Acad. Nat. Sci. Phila. Among the Oregon species this is related to *N. astori,* Ckll., and *N. corvallisensis,* Ckll. From *astori* it is easily distinguished by the much shorter fourth antennal joint and the absence of black marks at sides of first abdominal segment. From *corvallisensis* it is known by its lighter, brighter color, the much smaller punctures of mesothorax, and the hind femora not black behind.

Nomada ultimella, sp. n.

♀.—Length about 6½ mm.; another red species similar to *N. erythræa*, but distinguished by the characters given in the table. It is also near to *N. ultima*, Ckll., but easily separated by its smaller size, lighter color, with less black marking, and less prominent scutellum. Lower corners of face yellow; ocelli on a black patch; thorax without distinct bands, but the mesothorax and metathorax have barely indicated blackish median bands; sides of first abdominal segment with faint blackish stripes; second and third segments with small lateral yellow spots; stigma orange-fulvous; second and third submarginal cells both very greatly narrowed above; basal nervure ending a little basad of transverso-medial; third antennal joint a little shorter than fourth.

Hab.—"So. Cal.," one in Coll. Acad. Nat. Sciences Phila.

Nomada latifrons, sp. n.

♀.—Length about 9 mm.; a red species similar to *N. erythræa*. Head transversely oval, face very broad, especially above; ocelli on a black patch which extends considerably laterad of them; a similar transverse black patch on front, joining ocellar patch by two bands; cheeks black except the broadly red orbital margin; mesothorax and metathorax each with a single black band; abdomen with a blackish dorsal suffusion on segment 3, and a slight stain on 4 and 5, but no other black, nor any yellow spots; legs red, coxæ largely black behind; hind femora with about half the posterior surface black; third antennal joint a little shorter than fourth; wings strongly yellowish-smoky; stigma dark ferruginous; third submarginal cell greatly narrowed above; basal nervure ending a short distance basad of transverso-medial; abdomen of the long and comparatively narrow type.

Hab.—Santa Cruz Mts., Cal.; two in U. S. Nat. Museum. Differs from *N. erythrochroa*, Ckll. by the black markings, the finely roughened (not distinctly punctured) abdomen, and the much broader face; from *N. corvallisensis*, Ckll., by the very much broader face and much less coarsely sculptured mesothorax; from *N. clarkii*, Ckll., by its shorter head in proportion to its breadth, much narrower abdomen and different venation.

Nomada tintinnabulum, sp. n.

♀.—Length about 6½ mm.; a red species similar to *N. erythræa*. Eyes pale gray; facial quadrangle a little longer than broad; extreme lower corners of face yellowish; face red entirely without marks; a rather prominent keel between antennæ; ocelli on a small black patch; cheeks all red; antennæ entirely red, third joint a trifle shorter than fourth; dorsum of thorax without hair; mesothorax and metathorax

with a median blackish band; legs red without black markings, even the coxæ all red; wings yellowish-smoky; stigma dull ferruginous; basal nervure ending a short distance basad of transverso-medial; abdomen red without yellow spots, hind margins of segments more or less golden; first segment with a median black bell-shaped mark; pygidium narrowly rounded at end.

Hab.—Santa Cruz Mts., Cal., one in U.S.Nat. Museum. Differs from *N. corvallisensis* by its lighter color and narrower and much more finely sculptured mesothorax; from *N. oregonica* by the absence of yellow spots on sides of second abdominal segment. the venation and the immaculate face and pleura. The name *tintinnabulum* refers to the bell-shaped mark.

Nomada atrofrontata, sp. n.

♀.—Length about 8 mm.; rather dark red, marked with black, little hairy (hair on scutellum dark, on sides of metathorax white); eyes pale greenish-gray; facial quadrangle a little broader than long, scarcely narrowed below; extreme lower corners of face yellowish; front black from antennæ upward, and over to cheeks, leaving the orbital margins (broadly except at top of eyes, where narrowed to a line) red; antennæ red, except the small second joint, which is dark, contrasting with the others; flagellum suffused with bluish-gray; third antennal joint a very little *longer* than fourth; mesothorax very densely and minutely punctured, with a broad median black band; scutellum with a narrow median black band; metathorax with a broad band; sides of prothorax (except tubercles, which are yellowish) black; area between wings and middle and hind coxæ black; legs red, coxæ with much black; wings smoky, stigma dull ferruginous; second submarginal cell large, quadrate, nearly square, parallel-sided; third narrowed almost to a point above; basal nervure ending a considerable distance basad of transverse medial; abdomen rather broad, shining, convex, red with obscure yellow spots on sides of third, fourth and fifth segments, and a pair on dorsum of fifth; third and fourth segments with some median blackish suffusion; first segment with a broad black band on each side.

Hab.—"So. Cal.," one in Coll. Acad. Nat. Sciences Phila. Allied to *N. ultima*, Ckll., but the head is not so broad, and the proportions of the third and fourth antennal joints, and the venation, are very different.

Nomada excellens, sp. n.

♀.—Length about 11 mm.; robust, red marked with black. Head and thorax quite hairy, the hair of the dorsal parts pale brownish, that of the sides and under parts dull white; eyes pale yellowish-green;

head broad, facial quadrangle considerably narrowed below; front and cheeks marked with black as in *N. atrofrontata*, except that the red orbital margin is not narrowed quite to a line at top of eyes, there is a dull red spot before anterior ocellus, and a black line runs down from each antenna to middle of side of clypeus; antennæ entirely red (including second joint), *third joint conspicuously longer than fourth;* mesothorax with three black stripes, the middle one much the broadest; scutellum prominent, it and the postscutellum red; metathorax black with a large red spot on each side; prothorax black or blackish except upper border and tubercles; pleura red; legs red, only the coxæ marked with black; basal joint of hind tarsi broad, the short hair on the inner side shining pale golden; wings moderately smoky, nervures fuscous; stigma quite small, ferruginous; second submarginal cell rather strongly contracted above, *receiving the recurrent nervure far beyond its middle;* third submarginal cell very narrow, of the same breadth above as the second; basal nervure ending a moderate distance basad of transverso-medial; abdomen impunctate but minutely roughened, very broad, red, with a blackish stain on middle of second segment; no yellow spots; first segment with lateral cuneiform black marks, the points directed latero-posteriorly, and two smaller oblique marks in the dorsal region between them, all being near the base of the segment.

Hab.—"So. Cal.," one in Coll. Acad. Nat. Sciences Phila. Something like *N. clarkii*, but a very distinct species, not quite falling in *Nomada* s. str., as defined by Robertson.

Nomada angelarum, sp. n.

♀.—Length about 8½ mm., dark red with black markings, abdomen chestnut-red with a purplish luster, hind margins of segments broadly coppery-red. Hair of scutellum, mesothorax and vertex fuscous; of sides of metathorax, hind coxæ, pleura, cheeks and face rather abundant, white; eyes gray; face a little narrowed below; upper part of clypeus, supraclypeal region, front, vertex, occiput and cheeks black, except that the orbital margins are broadly red, the red sending a pointed projection into the black on vertex; antennæ long, red, first three joints more or less black behind; scape with dark hairs; face with some dark hairs amongst the white; third antennal joint conspicuously shorter than fourth; thorax densely rugoso-punctate; mesothorax with three black bands of nearly equal breadth; metathorax black, with an extremely obscure reddish spot on each side, and a pair of well-defined large round red spots on the enclosure; nearly all of pleura and tubercles red, but sides of thorax otherwise black; legs red; coxæ largely black; middle femora black beneath at extreme base; hind

'emora strongly suffused with black behind; middle tibiæ with a black stripe behind; hind tibiæ and tarsi strongly suffused with plumbeous behind; spurs yellowish-white; wings fairly clear, strongly darkened on apical margin; stigma dark ferruginous; second submarginal cell much broader above than third; basal nervure ending a considerable distance basad of transverso-medial; abdomen only moderately broad; first segment with the basal two-fifths (at least) black, the hind margin of the black nearly straight, though more or less crenulated; sides of second to fourth segments with small cream-colored spots, that on second largest, elongated in an antero-posterior direction; fourth and fifth segments with small sublateral cream-colored spots (thus four spots in all on fourth); venter red, second to fourth segments with cream-colored marks, second with a large black blotch.

Hab.—Los Angeles county, Cal. (*Coquillett*). One in U. S. Nat. Museum. Allied to *N. oregonica*, Ckll., but differs by the numerous abdominal spots, the purplish-coppery colors of abdomen, and the absence of a red spot before middle ocellus.

'omada davidsoni, sp. n.

♀.—Length 9 mm.; face, cheeks and sides of thorax with rather abundant white hair; head and thorax rugose, black; eyes gray; facial quadrangle not far from square, but narrowed below; basal half of mandibles, labrum, broad anterior margin of clypeus, and linear (inconspicuous) lateral face-marks reaching about to level of antennæ, dull yellow; scape black, very hairy; flagellum blackish above and ferruginous beneath; third antennal joint shorter than fourth; tubercles reddish with a yellow spot; pleura with an angular red mark on lower part; scutellum dark red, suffused with black in middle posteriorly; a small orange spot before each anterior corner of scutellum; postscutellum red in middle and yellow at sides; metathorax all black; tegulæ ferruginous; a reddish patch, becoming yellow posteriorly, before each middle coxa; legs red; anterior and middle femora more or less black beneath, hind femora black behind except at extreme apex; anterior tibiæ with a black stripe on outer side; hind tibiæ with a large black subapical spot on each side; knees and apices of tibiæ with more or less distinct cream-colored spots; hind tarsi strongly blackened without; wings moderately dusky, stigma dull ferruginous with a dark brown border; second submarginal cell little narrowed above; basal nervure meeting transverso-medial on the basad side; abdomen only moderately broad, minutely roughened, pale red with large cream-colored markings; basal half of first segment black; on the first three segments are pairs of large cream-colored triangles pointing mesad, the

first two pairs having a red spot on or near the hind margin, the third (on third segment) almost divided into two by an anterior intrusion of the red; fourth and fifth segments with broad cream-colored bands, deeply notched at the sides anteriorly, the notches rounded; venter red, with six rib-shaped (curved) whitish marks.

Hab.—"So. Cal.," one in Coll. Acad. Nat. Sciences Phila. Named after Dr. A. Davidson, who has discovered many Californian bees. The general appearance of the insect recalls *N. articulata*, Sm., while the details of the markings on thorax and abdomen remind one of *N. decempunctata*, Ckll.

Nomada subvicinalis, sp. n.

♂.—Length about 8½ mm.; pubescence of head and thorax quite abundant, brown dorsally, white on face, sides and under parts; head and thorax black, rugoso-punctate; facial quadrangle nearly square; mandibles (except tips), labrum, clypeus, lateral face-marks and narrow stripe extending half-way up posterior orbits, lemon-yellow; lateral face-marks extending as rather narrow bands up anterior orbits as far as level of antennæ, where they end abruptly, slightly bending inward; scape rather stout, yellow in front, black behind; flagellum long, bright ferruginous, with a black streak above on basal joints; third antennal joint much shorter than fourth; upper border of prothorax, tubercles, and a mark on lower anterior part of pleura, yellow; scutellum with two small and obscure red spots; thorax otherwise wholly black; legs bright red; hind coxæ black behind except at apex; middle and hind femora with a black spot beneath at base; tegulæ ferruginous; wings quite long, clear, dusky at apex; nervures fuscous; stigma rather small, dull ferruginous; second submarginal cell subtriangular, much narrowed above; basal nervure ending some distance basad of transverso-medial; abdomen minutely roughened, bright orange-ferruginous apex pointed rather acutely; extreme base of first segment with a small black patch emitting three short prongs; sides of second and third segments with a large rounded yellow spot, not at all pointed mesad; fourth segment with small lateral spots, sixth obscurely yellow; apical plate narrow, strongly notched; venter pale ferruginous marked with yellow, the yellow on second segment forming a large patch.

Hab.—"So. Cal.," one in U. S. Nat. Museum. Related to *N. vicinalis* Cresson.

Nomada marginella, sp. n.

♀.—Length about 7½ mm.; head and thorax black, rugoso-punctate, with white pubescence, rather abundant on face, cheeks, pleura, sides

of metathorax, and middle and hind coxæ; facial quadrangle nearly square, but broader above than long; mandibles except tips, rather broad upper margin of labrum, rather broad anterior margin of clypeus, and extreme lower corners of face sending a just visible line along orbital margin up to level of antennæ, all yellow more or less tinted with reddish; scape black; flagellum dark ferruginous, becoming blackish above on basal two-fifths; third antennal joint shorter than fourth seen from below, but a trifle the longer seen from above; tubercles and tegulæ ferruginous; a very small but very distinct dull yellow spot before each anterior corner of scutellum; postscutellum reddish in middle, yellow at sides; upper border of prothorax with two small yellow marks; scutellum, metathorax and pleura entirely black; legs ferruginous, coxæ and trochanters nearly all black; anterior femora with a black mark beneath at base; middle and posterior femora with the basal and upper parts largely black or blackish; most of the hind surface of posterior femora black; hind tibiæ with a yellowish-white mark at base and one at apex, the later with a blackish cloud on each side of it; apical pointed process of hind tibiæ unusually long; wings dusky at apex; stigma reddish-brown with a dark-brown margin; second submarginal cell quadrate, little narrowed above; third much narrowed above; basal nervure ending opposite transverso-medial, slightly on the basad side; abdomen rather narrow, pale ferruginous; first segment with basal half black, the black sending a pointed projection backward in the middle line; cream-colored marks as follows, two oblique small marks on the red of first segment, large lateral pyriform (pointed mesad) marks notched posteriorly on second, similar marks so deeply notched anteriorly as to be almost divided into two on third, broad band on fourth deeply notched laterally and very slightly divided in middle line, transversely placed hour-glass-shaped mark on fifth; base of fourth segment and practically all of fifth except the light mark, black; venter ferruginous more or less suffused with blackish, and with four crescentic cream-colored marks.

Hab.—"So. Cal.," one in Coll. Acad. Nat. Sciences Phila.

Nomada oregonica, Ckll.

Hab.—"So. Cal.," one ♂ in Coll. Acad. Nat. Sciences Phila.

Nomada bifurcata, sp. n.

♂.—Length about 6 mm.; head and thorax black, with abundant long hair, the dorsal hairs brownish, the others white; facial quadrangle nearly square; mandibles except tips, labrum, clypeus and lateral face-marks pale yellow; lateral face-marks broad below, rapidly nar-

rowing to a line which ends at level of antennæ; the face-markings are almost as in *N. sayi*, Rob., but the face is not so densely covered with hair as in that species; scape hairy, black, with a red spot at base in front; flagellum long, rather crenulated, dull reddish-brown beneath, blackish above; third antennal joint hardly more than half length of fourth, which is unusually long; thorax all black, except an obscure reddish spot on tubercles; tegulæ shining pale testaceous; legs yellowish-red, basal parts and femora beneath blackened; first four tibiæ with a blackish stripe on the outer side, the stripe on hind tibiæ is more obscure; hair on inner side of basal joint of hind tarsi very pale yellowish; wings quite long, nearly clear, slightly dusky at apex; stigma dull reddish-brown; second submarginal cell square, not in the least narrowed above; third narrowed almost to a point above; basal nervure ending a short distance basad of transverso-medial; abdomen rather narrow, shining yellowish-ferruginous; basal two-thirds of first segment black; second segment blackish basally at sides; second, third and fourth segments with yellow lateral spots, easily overlooked because of the yellowish-red of the abdomen; sixth segment with a very obscure short yellowish band; apical plate strongly bifurcated at end, with two sharp points; venter pale red without markings, the first segment mainly black.

Hab.—"So. Cal.," one in Coll. Acad. Nat. Sciences Phila. Allied to *N. sayi*, Rob.

Nomada elegantula, sp. n.

♀.—Length about 6 mm.; head and thorax black, moderately hairy; facial quadrangle nearly square, a little narrowed below; labrum dark; mandibles, narrow anterior margin of clypeus, and extremely narrow stripe on anterior orbits nearly up to level of antennæ, pale ferruginous suffused with yellow; scape black with a large red basal batch in front; flagellum ferruginous beneath, dark brown above, except first (third antennal) joint, which is red, with the margin prominent; third antennal joint a trifle longer than fourth; thorax black without light marks except the reddish tubercles; legs red; anterior and middle femora with a black stripe above and beneath; anterior and middle tibiæ blackish behind; hind legs black or nearly so, femora beneath at apex, and tarsi beneath in middle, red; wings rather long, nearly clear, apex dusky; stigma practically black; second submarginal cell square, not narrowed above; transverso-medial nervure a little basad of end of basal; abdomen narrow, bright coppery-red; base and sides of first segment, spots on extreme lateral margins of second and third (followed

by yellowish marks), fourth segment except anterior and posterior margins, and fifth except two rather obscure yellowish spots, all black; apex of fifth with a short fringe of silvery-white hair; venter dark with six pale marks.

Hab.—Los Angeles county, Cal., bearing number 397, one in U. S. Nat. Museum, marked "through C. V. Riley," presumably collected by Coquillett. Three others, marked "So. Cal.," are in Coll. Acad. Nat. Sciences Phila. The venation and other characters show that this cannot be the ♀ of *N. bifurcata*.

NORTH AMERICAN BEES OF THE GENUS NOMADA.

BY T. D. A. COCKERELL.

Nomada superba, Cresson, var. a.

♂.—Smaller (about 10 mm. long); basal nervure meeting transverso-medial, but on the basad side; lateral face-marks truncate above, but sending beyond a fine line to top of eye; lower part of posterior orbits with a yellow stripe.

Hab.—Cheyenne, Wyoming, June 15 (collection C. V. Riley); one in U. S. National Museum. If the characters are constant in the locality (which is quite a new one for the species) this may be a valid subspecies.

The following species more or less resemble *Nomada luteola*, and may be conveniently treated together:

Males.

All have scape yellow in front; mesothorax black; abdomen with yellow bands, that on second segment entire or interrupted by a line only.

1. Scutellum all black; tegulæ testaceous; supraclypeal mark absent; flagellum bright ferruginous beneath, not denticulate; band on first segment broadly interrupted; bands on second and third with a linear interruption, ... *dentariæ*, Rob.
   Scutellum yellow or spotted with yellow, ... 2.
2. Transverse medial nervure a little basad of basal; third antennal joint not over (rather less than) half length of fourth; postscutellum and metathorax wholly black (California), *sanctæcrucis*, Ckll.
   Basal nervure meeting transverso-medial; postscutellum largely or wholly yellow, ... 3.
   Basal nervure ending distinctly (often greatly) basad of transverse medial, ... 5.
3. Metathorax all black, scape very stout (Washington State), *pascoensis*, Ckll.
   Metathorax with much yellow; face narrow, facial quadrangle longer than broad, not narrowed below, ... 4.
4. Mesothorax wholly black; apex of abdomen entire . *vincta*, Say.
   Mesothorax with lateral margins yellow; apex of abdomen very faintly notched, ... *zebrata*, Cress.

5. Legs red; metathorax with four pale spots; apex of abdomen notched, ... *elrodi*, Ckll.
Legs yellow and black, sometimes with red suffusion, especially toward base, ... 6.
6. Apex of abdomen entire; the red on legs preponderating, *affabilis*, Cress.
Apex of abdomen notched, though sometimes obscurely; legs with less red, if any, ... 7.
7. Pleura with a large transverse yellow patch, ... 8.
Pleura with a smaller yellow mark, below tubercles, . . . 9.
8. The yellow patch almost divided in the middle; scutellum and lateral margins of mesothorax yellow, . . *sulphurata*, Smith.
The yellow patch not so; scutellum with two yellow spots; mesothorax all black, ... *rivalis*, Cress.
9. Lateral face-marks not going above level of antennæ; small yellow spots on scutellum and metathorax (Europe), . *succincta*, Panz.
Lateral face-marks continued narrowly to top of eye, . . . 10.
10. Eyes conspicuously diverging above; flagellum not denticulate; tibiæ yellow with a black spot behind, ... *civilis*, Cress.
Eyes not or hardly diverging above; orbits yellow except at summit behind, ... 11.
11. Flagellum denticulate beneath; anterior tibiæ wholly yellow; yellow band on first abdominal segment interrupted, *luteoloides*, Rob.
Flagellum not or obscurely denticulate beneath; third antennal joint little shorter than fourth; anterior tibiæ with a black mark behind; band on first abdominal segment entire, or reddish in middle, ... *luteola*, Lep.

Females.

1. Third antennal joint longer than fourth; basal nervure hardly or not far basad of transverse medial, ... 2.
Third and fourth joints subequal, or third shorter than fourth, 6.
2. Mesothorax red; front red, no yellow spot in front of middle ocellus; legs red; basal nervure almost meeting transverse medial, ... *zebrata*, Cress.
Mesothorax red and black, ... *vincta*, Say, var.
Mesothorax black, ... 3.
3. Legs red; third submarginal cell narrow, *vincta*, Say (also *zebrata*, var.).
Legs yellow and black; a yellow spot in front of middle ocellus; posterior orbits yellow, ... 4.
4. Legs red basally; mesothorax all black, *xanthophila*, Ckll., var. *pecosensis*, Ckll.
Legs not red basally; mesothorax yellow at sides, or with a yellow spot on each side, ... 5.
5. Mesothorax with two yellow stripes on disk, . . *edwardsii*, Cress.
Mesothorax without yellow stripes on disk, . *edwardsii*, Cress., var.

6. Posterior orbital margin black (Europe), . . . *succincta*, Panz.
   Posterior orbital margin broadly yellow, ... 7.
7. Mesothorax red without yellow stripes; legs red and yellow, 8.
   Mesothorax red with yellow stripes, ... 10.
   Mesothorax black, with or without stripes, ... 11.
8. Third submarginal cell short; basal nervure considerably basad of transverso-medial, ... 9.
   Third submarginal cell long; basal nervure almost meeting transverso-medial, ... *citrina*, Cress., var. *rufula*, Ckll.
9. Third antennal joint long; fourth considerably longer than fifth, *morrisoni*, Cress., var. *flagellaris*, Ckll.
   Third antennal joint shorter; fourth scarcely longer than fifth, *morrisoni*, Cress.
10. Third antennal joint scarcely shorter than fourth; fifth about equal to third, ... *luteoloides*, Rob.
    Third antennal joint very much shorter than fourth, . *luteola*, Lep.
11. Face square, tegulæ yellow, ... 12.
    Face broader than long, ... 13.
12. Third submarginal cell very narrow; flagellum mostly dark, *sulphurata*, Smith.
    Third submarginal cell broad below; flagellum fulvous-red beneath, ... *citrina*, Cress, var.
13. Lateral face-marks receding from orbits above; end of flagellum black above, ... *citrina*, Cress.
    Lateral face-marks following orbits to top of eye; end of flagellum not black above, ... *civilis*, Cress.

The species of this group (*Xanthidium* and part of *Holonomada* of Robertson) are very variable, and in my preliminary examination of them I separated out several supposed species which I have now concluded to treat as varieties only.

Nomada dentariæ (Rob.).

I have a male from southern Illinois, sent to me several years ago as *N. luteola* by Mr. Robertson. As it clearly possesses the characters assigned to *dentariæ* by Robertson, I assume it to be that insect.

Nomada vincta, Say.

I have before me three specimens, all from Illinois, belonging to the Acad. Nat. Sciences Phila. The male is marked by Mr. Viereck: "mixed with *affabilis;* flagellum thicker than in *affabilis.*" One of the females has the mesothorax red, with a very broad black stripe in the middle; the other has it black, with a red stripe on each side above the tegulæ. The former specimen is marked by Mr. Viereck: "mixed with *luteola.*" Robertson says that *N. vincta* is autumnal; Mr. Fowler's California "*vincta,*" flying in May, is presumably another species.

Nomada zebrata, Cress.

The female varies a good deal in size, and looks much like *N. morrisoni.* I have before me the following specimens: Beulah, N. M., 8,000 feet, August, 1902, 1 ♂; South Fork, Eagle Creek, White Mts., N. M., about 8,000 feet, August 16, 1 ♀, collected by C. H. T. Townsend; Colorado Springs, Colo. (*L. Bruner*, No. 26), 1 ♀. A female in Acad. Nat. Sci. Phila., marked "Col. Snow" (I suppose from Colorado), has precisely the colors of *N. vincta*, but from the broad scutellum and postscutellum, etc., I take it to be a form of *zebrata*, the two species being very closely allied.

Nomada elrodi, sp. n.

♂.—Length about 10 mm., moderately slender; head and thorax black, with rather abundant pubescence; short and grayish dorsally, snow-white and conspicuously plumose on face, cheeks, pleura, etc.; facial quadrangle broader than long, orbits not far from parallel; labrum, mandibles except tips, broad band beneath eyes extending a little beyond middle of posterior orbits as a narrow stripe, clypeus, supraclypeal mark (covered by silver-white hair), and lateral face-marks, lemon-yellow; lateral face-marks very broad, ending a short distance above level of antennæ, the end rounded and diverging from the orbital margin; scape swollen but not excessively so, yellow in front, reddish with two large black spots behind; flagellum reaching to metathorax, bright ferruginous, the first four or five joints largely black above; third antennal joint about half length of fourth, fourth considerably longer than fifth; lateral borders of mesothorax red; upper border of prothorax, tubercles, large transverse mark on pleura (almost concealed by white hair), and most of scutellum, yellow; post-scutellum black; metathorax with four reddish-yellow spots, the upper two on the enclosure; tegulæ honey-color; wings long, not far from clear, apex dusky, stigma bright ferruginous, nervures ferruginous on basal half and fuscous on apical half of wing; second submarginal cell little narrowed above, third large; basal nervure a moderate distance basad of transverse medial; legs red; a spot at base of anterior femora beneath, basal half of under side of middle femora, and a suffused band on hind femora beneath, black; abdomen light lemon-yellow; basal half of first segment black, the edge of the black wavy; apical margins of all the segments reddish, broadest and darkest on the first three; apex slightly notched; venter yellow with pale ferruginous (marginal) bands, first segment ferruginous marked with a broad black V.

Hab.—"Montana," one in Coll. of Acad. Nat. Sci. Phila. Named

after Prof. M. J. Elrod, the Montana naturalist. Another (with mesothorax entirely black) is from Cedar Bluffs, Neb. (*L. Bruner*, No. 30).

Nomada sulphurata, Smith.

This has been regarded as a synonym of *N. luteola*, but it appears to me to be a perfectly valid species. I thought at first that *N. luteoloides*, Rob., might be a synonym of it, but the males at least certainly appear to be different. Compared with *N. luteoloides*, the male of *N. sulphurata* has a larger thorax and broader abdomen; the pleura shows a large irregular yellow mark, and a yellow spot beneath the wings; the scutellum is all yellow, the lateral margins of the mesothorax are yellow, and the metathorax has yellow lateral marks. The scape is more swollen, there is a yellow spot in front of anterior ocellus, and the whole of the face below the level of antennæ is yellow. The hind margins of the ventral surface of abdomen are broadly pale ferruginous. The flagellum is denticulate or warted beneath on the fifth to seventh segments from the end. The female has the mesothorax black, usually but not always with reddish-yellow stripes. The material of *N. sulphurata* before me, consisting of 1♂, 5♀, was collected by Mr. Viereck at Edge Hill, Pa., the male May 23, the females April 28 and May 5, 1901.

Nomada rivalis, Cress.

A male marked "W. T." (Washington State), from Acad. Nat. Sci. Phila., is before me. A female, also marked "W. T.," looks as if it belonged with the male, but the basal nervure meets the transverse medial, and the specimen is referred to *N. citrina*.

Nomada civilis, Cress.

A male from the National Museum is labelled "Colo., 1871," and is apparently from the Baker collection. I thought this might prove to be the male of *N. morrisoni*, but a couple of females from Corvallis, Ore., June 3, 1899, are so much like the male that I can only refer them to the same species. The characters given in the table separate them from *morrisoni*.

Nomada luteoloides, Rob., and **N. luteola,** Lep.

A female from Georgia, sent to me by Mr. Fox as *N. luteola*, has the yellow of metathorax encroaching upon the enclosure, as Robertson states for *luteola*, but the proportions of the antennal joints agree with *luteoloides*. A male from Georgia, received with the female, has the flagellum slightly denticulate beneath, and the orbits yellow except at summit behind, so it ought to be *luteoloides*. Nevertheless, the denticulation is feeble, and the anterior tibiæ have a black mark behind;

e metathorax has four dull yellow spots. The band on first abdomi-l segment is ferruginous in the middle. This does not precisely ree with either of the forms Mr. Robertson gets in Illinois; it seems fall between them. It does not agree with *N. sulphurata*, although at was described from Georgia. *N. luteola* was originally described m "Carolina," and I suspect that the Georgia specimens here de-ibed may truly represent that species, the Illinois insect of Robert-ı being different; but this is at present little better than a guess.

A female collected by Mr. Viereck at Clementon, N. J., May 22, 1898, genuine *N. luteola* as understood by Robertson. A couple of males m Mr. Viereck, one marked Montgomery county, Pa., are referred *N. luteola*. Two males in the National Museum belong to *N. luteo-des;* one is from "N. Ill." (*Belfrage*), the other from J. L. Zabriskie, rack, N. Y. A ♂ *luteoloides* is from Edge Hill, Pa., April 28, 1901 *iereck*).

mada edwardsii, Cress.

Variable in size. Females from Corvallis, Oregon, May and June *ordley*), and Washington State (Coll. of Acad. Nat. Sci. Phila.) k the two yellow stripes on disk of mesothorax. The stripes are sent in a female from Silver Lake, Utah, July 14 (*H. Skinner*).

nada xanthophila, Ckll., var. **pecosensis** n. var. (n. sp.?).

A female specimen was taken at the Kin Kale Ranch, Pecos, N. M., ne 26, 1903, by Wilmatte P. Cockerell. It has a good deal of resem-nce in color and markings to *N. suavis*, Cress., but it is by no means same. I refer it to *xanthophila*, because it looks like that species l is from the same general region, but it differs from the type ♂ by microscopically tessellate rather than punctured abdomen, the ght ferruginous stigma, the second submarginal cell conspicuously rowed above; first joint of labial palpi considerably longer than other three together, second considerably longer than the third and rth together; third antennal joint conspicuously longer than fourth. ıer characters, more likely to be merely sexual, are: Head rather ındantly hairy, though the face is almost bare; supraclypeal mark l-developed; scape yellow in front, otherwise ferruginous with a ck mark behind; antennæ reaching scutellum; sides of metathorax h very large yellow patches; pleura with a very large transverse low patch, and a yellow spot beneath the wings, no ferruginous at hind coxæ yellow in front; base and apical margin of first abdomi-segment black, the rest (a very broad band) yellow; no ferruginous second segment. The eyes are sage-green. From *N. superba* this

differs by being smaller, the basal nervure very little basad of the transverse medial, scutellum much less bilobate, mesothorax with only very short inconspicuous hair, outer side of third submarginal cell curved instead of angled, labial palpi pale ferruginous (darker, first joint almost black, in *superba*), etc. The *N. superba* compared is from S. Illinois (*Robertson*). The hump-like process seen on the sides of the metathorax in *superba* is barely indicated by a slight angularity in the Pecos insect. The length of the latter is about 11½ mm., and it is not so broad as *superba*. In Robertson's table of *Holonomada* the Pecos insect runs to *affabilis* and *vincta*, having the mesonotum coarsely punctured, nearly bare, flagellum red, its apical portion more or less suffused with blackish.

On the whole, I expect the Pecos bee to prove distinct from *N. xanthophila*, but as the two are so very much alike, and are known only by single examples of opposite sexes, I leave the female as a variety *pecosensis*.

Nomada succincta, Panz.

This is a *Xanthidium*, and looks much like our *N. sulphurata*. My examples are from Palma de Mallorca, Balearic Is. (*André*).

Nomada citrina, Cress.

I have before me three females from the Acad. Nat. Sciences Phila. One is from Washington State, without further data; the others are from Grangeville, Ida., "deposited by Wm. J. Fox." The Washington specimen is no doubt genuine *citrina*. The Idaho form has the face slightly narrower, and in one of them the head and thorax are red with yellow markings, the black being reduced to a few spots and patches. In this state the insect looks much like *N. morrisoni* or *zebrata*. In the Washington specimen the basal nervure meets the transverse medial; in the Idaho ones the basal is a trifle more basad. In Cresson's types (as I learn from Mr. Viereck) the basal nervure is from moderately to considerably basad of the transverse medial.

The red form from Idaho may be called *N. citrina* var. *rufula*. It has the antennæ entirely red, except that the scape is yellow in front; the front and vertex are bright red, except that the ocelli are on a black patch; mesothorax red, coarsely punctured, a little yellow in front of the tegulæ; scutellum with two large yellow spots separated by red; abdomen yellow with red bands, basal half of first segment red with four black or blackish spots; legs red and yellow, hind coxæ and femora heavily marked behind with black.

Nomada morrisoni, Cress.

Three females from the National Museum are from Colorado; two collected by Morrison, one marked "San Louis, Col., June 6, 1883.

uner." The last, I suppose from the San Luis Valley, is peculiar r having the nervure separating the first and second submarginal lls wholly wanting in both wings.

The var. *flagellaris* has the basal joints of the flagellum lengthened, indicated in the table. It is possibly a distinct species. It is from olorado (*Morrison*), in U. S. National Museum. It has the "anterior iddle of mesothorax" red like the rest, not black. The yellow of the etathorax extends upward to form two large spots on the enclosure. ie legs are without black, even on the coxæ.

MELANOMADA, subg. n.

Type *N. grindeliæ*, Ckll. The male, in Robertson's table, runs to *olonomada*, but is entirely black, without yellow markings. Size iall; *vertex and mesothorax smooth and shining;* apex of abdomen unded, entire; basal nervure meeting transverso-cubital; antennæ ort, third joint much longer than fourth, middle joints of flagellum ich wider than long. Female unknown.[1] The type was taken at ncoln, Neb., at flowers of *Grindelia*, in September. It is described in paper sent to *Am. Mag. Nat. Hist.* *A* second specimen (Coll. of ad. Nat. Sci. Phila.) is from Montana (no other particulars own); it is smaller (length about 6 mm.), with red mandibles and ldish stigma.

By the smooth mesothorax, *Melanomada* recalls the Mexican *N. iata*, Cresson.

mada magnifica, sp. n.

♀.—Length about 13½ mm., robust. "Colo., 1170, A. E. S. Coll., . J. Fox," with Mr. Viereck's note, "mixed with *grandis*." I confess at I should have taken it for *grandis*, had not Mr. Viereck found it ferent. In true *N. grandis*, as I learn from Mr. Viereck, the basal rvure is a long distance basad of the transverso-medial, as in *superba*, *vardsii* and *affabilis;* in *N. magnifica* the basal nervure meets the insverso-medial. The specimen of *magnifica* has the yellow parts iolly reddened by cyanide, but it seems to have been marked as in *indis;* the abdomen was certainly yellow with the hind margins the segments infuscated, and with the basal half of the first segment ruginous, with a dusky spot on each side. Other particulars are: ical part of mandibles black; mandibles simple, stout; head pracally without black, area about ocelli blackish; antennæ entirely red, rd joint longer than fourth; mesothorax coarsely and extremely

[1] Mr. J. C. Crawford writes that he has the ♀, and that it has a red abdomen.

densely punctured, with a blackish median band; scutellum prominent, apparently yellow, with very large punctures; enclosure of metathorax jet black, strongly contrasting with surrounding parts, having a well-defined little area of fine ridges on each side; tegulæ large, ferruginous, punctured; wings dusky, especially the apical margin very broadly; nervures brown; stigma small, ferruginous; second submarginal cell very broad, receiving the recurrent nervure less than a third of its width from the end; third submarginal cell rather narrow, with its outer side curved rather than bent; legs bright ferruginous.

The insect is evidently a *Holonomada*.

Nomada excellens, Ckll., var. a.

♀.—Lateral black stripes on mesothorax evanescent; red spots on metathorax larger; black spots at base of first abdominal segment evanescent.

Hab.—Nevada (no other particulars known); one in Coll. of Acad. Nat. Sci. Phila.

Nomada erigeronis, Rob.

♀.—Length about 11 mm., with a very broad abdomen. Has simple mandibles and large spines on front coxæ, and belongs to *Centrias*, of which it is the type species. The stigma is very small; second submarginal cell broad; basal nervure only just basad of transverso-medial. The specimen before me is from Nebraska (no other particulars known), in Coll. of Acad. Nat. Sci. Phila., where (as Mr. Viereck tells me) it was mixed with *N. belfragei*.

Nomada latifrons, Ckll., var. a.

♀.—Length about 9 mm.; the black ocellar area completely separated by red from the black area just above the antennæ.

Hab.—Nevada (no other particulars known); one in Coll. of Acad. Nat. Sci. Phila.

Nomada vinnula, Cress.

A new locality is Corvallis, Ore., June 1 to 10, several females (Cordley). The female is very near *N. edwardsii*, but has a broader face, pleura with only a yellow triangular mark, and mesothorax wholly black. I do not know how to separate the male from *edwardsii*, or it may be that all my males are *edwardsii*. Prof. Cordley took female *edwardsii* at Corvallis on April 3 and May 11.

Nomada nigrocincta, Smith.

Prof. Cordley took the female at Corvallis, Ore., June 3. The mandibles are simple, and the abdomen has distinct black bands. There is some yellow at the lower corners of face, and small inconspicuous

on each extreme side of third and fourth abdominal seg-
'd antennal joint considerably shorter than fourth.

sent to *Annals and Mag. of Nat. History*, I have described red species of *Nomada* from Corvallis, Ore.; but have le for their separation. The following table separates the from Corvallis, in which red is the preponderating color:

's bidentate; abdomen with yellow spots on second seg- ›nly, or none; third joint of antennæ as long as fourth; ıorax with a black median band, ... 2.
's simple, ... 5.
abdomen dark red; third submarginal cell narrowed to a point above; first abdominal segment with a black ›n each side, ... 3.
third submarginal cell not so much narrowed, . . 4.
egment with no distinct yellow spots (May 28),
bella, Cress., var.
egment with distinct yellow spots (May 9),
bella, Cress., var.
n shorter, dark red (April), ... *rhodomelas*, Ckll.?
n longer, light red (May), ... *grayi*, Ckll.
n with black bands (June), ... *nigrocincta*, Smith.
n without black bands, ... 6.
n with large yellow spots on second and third segments, ›r less of a band on fourth, etc.; third antennal joint about with fourth; a little yellow at lower corners of face (May une), ... *lewisii*, Ckll.
n with very small yellow spots or none, and no band, 7.
n without yellow spots, ... 8.
n with yellow spots (4 or 6); yellow at lower corners of third antennal joint shorter than fourth, ... 10.
;er, about 10 mm. long; third antennal joint almost as long ›rth; no yellow at corners of face; sides of abdomen with ed black marks (April), ... *clarkii*, Ckll.
ıller, about 8 mm. long, ... 9.
ıt lower corners of face; third antennal joint not more than ›ngth of fourth; sides of abdomen inclined to be black- ›d (May, June), ... *astori*, Ckll.
ıw at lower corners of face; third antennal joint at least as s fourth; abdomen dark red, its sides without black marks ', ... *corvallisensis*, Ckll.
ıbdomen with a black mark in middle, or black right across; antennal joint not much shorter than fourth (May, June),
oregonica, Ckll.
abdomen without a black mark in middle; third antennal much shorter than fourth (May, June), . *ultima*, Ckll.

a taraxacella, subsp. n.

th 7 mm., red; similar to *ultima*, but face narrower; meso- without any black stripes (three black stripes in *ultima*);

black marks on first abdominal segment evanescent. As in *ultima*, there is a black diamond-shaped mark on the metathorax. The width of the face seems to vary somewhat.

Hab.—Placita, N. M., at flowers of *Taraxacum taraxacum*, one, May 5, 1903 (*Cockerell*); Pecos, N. M., at flowers of *Fallugia acuminata* (*F. paradoxa acuminata*, Wooton), one, June 23 (*W. P. Cockerell*); near Viveash Ranch, N. M., 8,800 feet, at flowers of *Erigeron*, one, July 21 (*W. P. Cockerell*).

Nomada americana, Kirby.

This species seems to have a very wide distribution; specimens in the National Museum are from Canada, Colorado (with numbers 2,076, 2,185), and Louisiana (with numbers 2,564, 2,567, 2,420). They appear to come from the Baker collection. Two in Coll. of Acad, Nat. Sci. Phila., are from North Carolina. I also have the species from So. Illinois (*Robertson*) and Baldwin, Kans., June (*Bridwell*). It appears from the Bakerian numbers that this species is taken in Colorado along with *N. scita*. Now *scita* has a spine on the anterior coxa, and is very near to *americana*, though undoubtedly distinct. I cannot help thinking it possible that the Colorado *americana* females, though to all appearances genuine *americana*, are actually females of *scita*.[2]

The male of *N. americana* is quite variable; if I had only a large Canadian specimen and one of the smallest from Louisiana, I should think them different species. The Louisiana males (21 examined) vary greatly in size. One male is from Indiana, with number 2,003.

Nomada martinella, sp. n.

♀.—Length about 7 mm.; bright red. This was formerly supposed to be *N. incerta* = *americana;* but it differs in its smaller size; lighter color, especially of the thorax; mesothorax without a black band; face broader above; antennæ and legs entirely bright ferruginous red.

Hab.—Mesilla Park, N. M., April 9, at flowers of plum (*Cockerell*, 2,628). Named after my little son. Two specimens were taken. A supposed variety of the same species, somewhat larger (length about 8 mm.), with the second submarginal cell very much broader, and the tegulæ lighter and yellower and less punctured, was sent to me by Mr. Fox as *N. incerta*. It is from Colorado, and if its distinctive characters are constant it is presumably separable specifically. Possibly it is the true female of *N. scita*. A specimen from Sioux City, Neb. (*Bruner*, 29), is also referred to *N. martinella;* it has the second submarginal cell

[2] However, I find two males of *N. americana dacotana* labelled "Colo. 2,076."

comparatively narrow, as in *martinella*, but it receives the recurrent nervure far beyond its middle (at its middle in *martinella* type); in size it nearly agrees with *martinella;* the first joint of the flagellum is not much shorter than the second, seen from the front, whereas in *martinella* type it is considerably shorter.

All these insects are very easily separated from *N. americana* by the clear red antennæ and thorax without a black stripe. At a glance they look like *N. ultima taraxacella*, but they are *Centrias*, with strongly punctured abdomen and spines on front coxæ. They have not the black diamond on the metathorax, which is seen in *taraxacella*.

Nomada scitiformis, sp. n.

♂.—Length about 9 mm.; black with yellow markings; legs red and black. Flagellum constructed and colored as in *N. scita*, of which I had supposed this a variety, until I saw the real *scita* from Colorado. *N. scitiformis* differs from *scita* thus: Somewhat larger; clypeus low, no supraclypeal mark, and lateral marks shorter, so that the black area below the antennæ is much larger; postscutellum entirely black; abdominal bands lemon-yellow; first segment with no band, but only a spot on each side; band on second segment very broad at sides, rapidly narrowing mesad, where it is interrupted; legs a darker duller red, with more black; hind femora mostly black.

Hab.—Corvallis, Ore., June 2 to 8 (*Cordley*). Sometimes the clypeus has only the anterior margin yellow; and sometimes the first abdominal segment has an interrupted band, while that on the second is narrowly continuous in the middle. Five specimens examined.

N. scitiformis and also *N. scita* belong to *Centrias*, having a spine on the anterior coxa. The anterior legs of the males of these and *N. americana* differ thus:

N. scitiformis: Spine black, fairly long; red of leg fairly bright.

N. scita: Spine pale red, slender and rather long, directed caudad; red of leg bright.

N. americana: Spine red, short; red of leg not so bright.

Aside from these characters, the males of *Centrias* (+*Nomadula*) are easily separated thus:

1. Hind femora distinctly arcuate; base of abdomen with much red, *americana*, Kirby.
   Hind femora not arcuate; base of abdomen not red, ... 2.
2. Antenna without a pale annulus (middle region of flagellum), *erigeronis*, Rob.
   Antenna with a pale annulus, ... 3.
3. Hind femora with much black; no supraclypeal mark, *scitiformis*, Ckll.
   Hind femora bright red; a supraclypeal mark, . . *scita*, Cress.

The female *N. americana* is easily distinguished from the red species of *Gnathias* and *Nomada* s. str. by the strongly punctured abdomen: Kirby says nothing about this, and it is with some hesitation that I follow Robertson's identification of the species.

N. articulata, Smith (♂ from Brookings, S. Dak., June 8, 1891) has a long spine on the anterior coxa, and belongs to *Centrias*. The hind femora are arcuate, and the ground-color of the abdomen is mainly red. This specimen of *N. articulata* was identified by Mr. Fox, who gave it to me; but I find that it is not typical, and in fact Smith's description of *articvlata* applies to the ordinary male of *americana*. Kirby, as understood by Robertson. Hence, if any one should wish to discard Kirby's name as of uncertain application, *articulata* will be the proper name of the insect. I do not believe that *valida*, Smith, which has priority of place, is applicable.

The South Dakota insect, just referred to, may be described thus:

Nomada americana dacotana subsp. n.

♂.—Length about 9½ mm.; mesothorax largely dark red, leaving a broad median black band; lower inner angle of second submarginal cell produced; abdomen light red with yellow bands; basal half of first segment, and apical portion more or less, black; first segment with a yellow band narrowly interrupted in middle; band on second segment greatly narrowed but continuous in middle.

Hab.—Brookings, S. D., June 8. Also two specimens with band on second segment interrupted, marked "Colo., 2,076," in National Museum. Also three males from Montana (Coll. of Acad. Nat. Sci. Phila.).

Nomada rubicunda (Oliv.).

This is also a *Centrias*. I have before me six females collected by Mr. Viereck in New Jersey; one at Clementon, May 16, 1897, five at Riverton, April 29. The insect is easily distinguished from *americana* by the light bands on the apical half of the abdomen, these bands in the New Jersey form being creamy-white. The basal nervure is a little basad of the transverso-medial.

Nomada (Heminomada) obliterata, Cress.

A female from Indiana (Nat. Mus.) bears the Bakerian number 2,003. The species goes west even to Montana, as shown by two males in Coll. of Acad. Nat. Sci. Phila.. One of them, very curiously, has a triangular areolet on both sides at the beginning of the first recurrent nervure.

The following species are small (all under 10 mm. long), with numerous clear-cut yellow or white bands on abdomen:

Females.

1. Legs with much yellow; clypeus yellow; metathorax all black, *formula*, Viereck.
   Legs red, ... 2.
2. Markings yellow; punctures of mesothorax very coarse and dense (Las Vegas, N. M.), . . . *modesta*, Cress., var. *vegana*, Ckll.
   Markings cream-color; punctures of mesothorax well separated on a shining ground, ... *vierecki*, Ckll.

Males.

1. Apical plate of abdomen conspicuously notched; legs red, . 2.
   Apical plate of abdomen rounded or truncate, with at most a feeble emargination, ... 5.
2. Scape slender, ... 3.
   Scape swollen, yellow in front, ... 4.
3. Markings white, ... *vierecki*, Ckll.
   Markings yellow, ... *crucis*, Ckll.
4. Flagellum very long, entirely black above, denticulate; lateral face-marks narrow, ... *fragilis*, Cress.
   Flagellum black above at base and 2½ joints before the last; lateral face-marks broad, ... *scita*, Cress.
5. Legs red, ... 6.
   Legs with much yellow, ... 8.
6. Face covered with white hair; scape swollen, yellow in front, *sophiarum*, Ckll.
   Face practically bare; scape slender, ... 7.
7. Abdomen broader; lateral spots, but no band, on third segment, *lippiæ*, Ckll.
   Abdomen narrower; a band on third segment, *neomexicana*, Ckll.
8. Supraclypeal mark present; metathorax with much yellow, *suavis*, Cress.
   No supraclypeal mark; metathorax all black, . *verecunda*, Cress.

N. vierecki, *crucis*, *sophiarum*, *lippiæ* and *neomexicana* have been described in a paper sent to *Annals and Mag. of Nat. History*. The *N. suavis* before me is a single example from California, from the National Museum. *N. fragilis* I recognize in a specimen which I collected at Pecos, N. M., June 21, 1903, at *Salix*. It is a *Xanthidium*, and is not allied to the other species in the above table. The third antennal joint is exceedingly short, and the basal nervure is a little basad of the transverso-medial.

Of *N. scita* I have before me five examples; one from Montana (Acad. Nat. Sci. Phila.), the others from Colorado, apparently from the Baker collection, bearing numbers 2,076 and 2,185 (National Museum).

Of *N. verecunda* I have before me five from Nevada (Coll. of

Acad. Nat. Sci. Phila.). They differ very much from one another, and I thought at first to separate two species, one larger, with the scape yellow in front, the other smaller, with the scape dark. I think, however, they are certainly all one species. The transverse medial nervure is basad of the basal; a peculiar character, shared (as I learn from Mr. Viereck) by *N. adducta, putnami, suavis, snowi* and *heiligbrodtii.*

Nomada ruidosensis, sp. n.

♂.—Length 7 mm.; in the above table it runs doubtfully to *N. fragilis*, with which I had confused it; it differs, however, as follows: Head narrower; facial quadrangle almost square, not broadened above; no supraclypeal mark; upper part of lateral face-marks narrower; scape little swollen, dull reddish-yellow in front; flagellum (long as in *fragilis*) more slender; third antennal joint, *seen from above*, very little shorter than fourth; a small yellow spot on pleura, but no yellow on scutellum; general tint of legs darker, the black more suffused; first abdominal segment entirely black; yellow band on second segment narrowly interrupted. The flagellum is not denticulate.

Hab.—Ruidoso creek, New Mexico (*E. O. Wooton*, No. 67).

Allied to *N. dentariæ*, Rob., but much smaller. The basal nervure meets the transverso-medial, but a little on the basad side. The second submarginal cell is very broad above. The ventral surface of the abdomen is dark brown, with obscure markings.

Nomada elegantula, Ckll.

A new locality is Lewiston, Idaho, one in Coll. of Acad. Nat. Sci. Phila., "deposited by Wm. J. Fox."

The following species have bidentate mandibles, and belong to Robertson's genus *Gnathias:*

Females.

1. Abdomen without yellow spots, ... 2.
   Abdomen with yellow spots, ... 4.
2. Head and thorax dark; scape dark, with a red basal spot, *perplexa*, Cress., var.
   Head and thorax lighter; scape entirely red in front, . . . 3.
3. Mesothorax and metathorax with a black median band (Louisiana), ... *louisianæ*, Ckll.
   Mesothorax and metathorax without a black median band (Nevada), ... *rhodalis*, Ckll.
4. Fifth abdominal segment with yellow spots, ... 5.
   Fifth abdominal segment without yellow spots, ... 8.
5. Lower anterior orbits yellowish; pygidium ovate; mesothorax commonly with three stripes, ... *ovata* (Rob.).

Lower anterior orbits not yellowish; mesothorax with not more than one stripe, ... 6.
6. Larger; 10 mm. long or over; red of abdomen quite bright, *bella*, Cress.
Smaller; 8 or 9 mm. long, ... 7.
7. Red of abdomen dark, ... *cuneata* (Rob.).
Red of abdomen light (Colorado), ... *schwarzi*, Ckll.
8. Length over 10 mm.; abdomen rather long, ... 9.
Length under 10 mm., ... 10.
9. General color darker (Pa., N. H.), ... *bella*, Cress., var.
General color lighter (Wash., Ore., B. C.), . . *bella*, Cress., var.
10. Dark species; scape in front black or blackish, with red basal spot, *perplexa*, Cress.
Scape in front red, ... 11.
11. Two submarginal cells, ... *grayi eastonensis*, Ckll., var.
Three submarginal cells, ... 12.
12. Yellow spots on second abdominal segment small and inconspicuous, ... 13.
Yellow spots on second abdominal segment conspicuous, . . 16.
13. Face very broad; orbits hardly converging below; third submarginal cell very high and narrow, but not much narrowed to marginal (Wash.), ... *washingtoni*, Ckll.
Face narrower; orbits conspicuously converging below, . . 14.
14. Third submarginal cell narrowed nearly or quite to a point above, broad below (Wash.), ... *grayi eastonensis*, Ckll.
Third submarginal cell not thus narrowed above, ... 15.
15. Abdomen long, light red; only a little black at base of first segment, ... *grayi*, Ckll.
Abdomen shorter, broader and darker; much more black at base of first segment (Oregon), ... *rhodomelas*, Ckll.?
16. Smaller and lighter (North Carolina), ... *carolinæ*, Ckll.
Larger and darker (N. H., Pa., Ind., Kans., Neb.). *cuneata* (Rob.).

Males.

1. Scutellum usually spotted with yellow; tegulæ more or less yellow, ... 2.
Scutellum black or red; tegulæ ferruginous, ... 3.
2. Middle joints of antennæ not longer than wide, . . *ovata* (Rob.).
Middle joints of antennæ longer than wide (Texas), *lepida*. Cress.
3. Clypeus with only the anterior margin yellow, though often broadly, ... 4.
Clypeus all or with the greater part yellow, ... 7.
4. Abdomen broad, very dark red, with two widely distant spots on second segment, and usually on third, . . . *perplexa*, Cress.
Abdomen lighter, ... 5.
5. Second submarginal cell receiving recurrent nervure beyond its middle; abdomen light red with four large yellow spots; scape black in front; second submarginal cell narrow (Oregon), *rhodomelas*, Ckll.

Second submarginal cell receiving recurrent nervure before or at its middle, ... 6.

6. Larger; yellow marks on second abdominal segment almost meeting in middle line, ... *bella*, Cress.

Smaller; yellow marks on second abdominal segment widely separated, ... *cuneata* (Rob.).

7. Abdomen long and narrow, bright red, with very widely separated yellow spots on second and third segments; second submarginal cell receiving recurrent nervure a little beyond its middle; scape red tinged with yellow in front; second submarginal cell broad (Nevada), ... *physura*, Ckll.

Not so, ... 8.

8. Rocky Mountain species; mesothorax with more or less red; lateral margins of metathoracic enclosure curved inward; third antennal joint on upper side at least as long as fourth; no black spots on red part of first abdominal segment, ... 9.

Species of the country east of the Rocky Mountains, going west in the north to Washington State; mesothorax rarely with any red, when with red, lateral margins of metathoracic enclosure practically straight, ... 10.

9. Third antennal joint short; second submarginal cell narrowed above, and receiving the recurrent nervure at or before its middle (New Mexico), ... *schwarzi contractula*, Ckll.

Third antennal joint longer; second submarginal cell broader above, and receiving the recurrent nervure beyond its middle (Colorado), ... *schwarzi*, Ckll.

10. Mesothorax largely red (Lehigh Gap, Pa.), . *perplexa*, Cress., var.

Mesothorax black, ... 11.

11. Size largest; length nearly 10 mm.; eyes usually pale; abdomen usually with well-developed yellow bands, . . *bella*, Cress.

Size medium; length little over 7 mm., sometimes smaller, . . 12.

Size smallest; length about 6 mm. or less, . . *cuneata* (Rob.).

12. Scape light red in front; spots on light part of first abdominal segment practically obsolete; scutellum largely red (New York), *cuneata* var.?

Scape black or dark red in front, ... 13.

13. Scape black in front; eyes gray; scutellum black; abdomen with cream-colored bands, ... *albofasciata*, Smith.

Eyes black or nearly so; scutellum black or red; two black spots on first abdominal segment distinct (Wisconsin), *cuneata* var.?

Nomada lepida, Cresson.

♂.—Length 7½–8½ mm.; head and thorax black, with abundant hair, white except on vertex and dorsum of thorax, where it is tinted with brownish-gray, so as to appear dirty; facial quadrangle longer than broad; labrum, basal part of mandibles, clypeus (but no supraclypeal mark), and narrow lateral face-marks extending to level of antennæ, lemon-yellow; posterior orbits with a narrow yellow line extending

ıbout half-way up; scape scarcely swollen, dull yellow and striato-ɔunctate in front; flagellum rather dark ferruginous, the basal half nore or less black above; third antennal joint shorter than fourth; :horax very densely punctured; narrow stripe on upper margin of pro-:horax, tubercles, round spot (not conspicuous) on anterior part of ɔleura (sometimes absent), and two oval spots on scutellum (which nay be absent or represented by very small reddish-yellow spots), all ɾellow; an orange stripe on postscutellum, and an orange dot at each ınterior corner of scutellum, may be well-developed or practically obso-ete; tegulæ more or less pale yellow; wings clear, dusky at apex, ıervures dark brown, stigma dark ferruginous; second and third sub-narginal cells equally broad above, or the second may be somewhat ɔroader; basal nervure a considerable distance basad of transverso-nedial; legs pale ferruginous, with yellow knees and yellow stripes on :he tibiæ; most of coxæ, base of middle femora, and hind femora except ıpex, black; abdomen dark brown with six bright yellow bands, that ɔn second segment very broad, and not much narrowed in the middle, :hat on fourth inclined to be narrowly interrupted; apex bidentate; ɾenter dark reddish marked with yellow.

Hab.—Round Mountain, Tex., three in Coll. of Acad. Nat. Sci. Phila. ꞇollector unknown. Also two from Colorado (Baker collection, No. .,871), in the National Museum. The species has been recorded from ʀock Island, Ill., and Berkeley, Cal., but possibly the specimens from he latter locality may be wrongly determined.

Mr. Viereck very kindly went over the whole Cresson collection to ee if there were any species of *Gnathias* not recognized as such by me. Ie found only *N. lepida; N. amœna* was not in the collection, and ould not be examined. I had described *N. lepida* as new, and it is nly Mr. Viereck's reference of it to *Gnathias* that has enabled me to orrect the error. I let my description stand, as it will probably be seful.

'omada grayi eastonensis, subsp. n.

♀.—Length about 8 mm.; red. Differs from *N. grayi* by the third ıbmarginal cell narrowing to a point above, the anterior orbits diverg-ıg less above, and the greater amount of black at the base of the first bdominal segment. In the type specimen, and also in the type of *ꞁ. grayi*, the first ventral abdominal segment has a black mark resem-ling a fish-tail.

Hab.—One specimen, marked "Easton, Wash., K.," is in the Na-ional Museum. Another marked "W. T." in Coll. of Acad. Nat. Sci.

Phila. is referred to *eastonensis*, but is peculiar for having the nervure between the second and third submarginal cells wanting.

Nomada rhodomelas, sp. n.

♂.—Length about 8 mm.; head and thorax black, extremely closely punctured; facial quadrangle nearly square; anterior margin of clypeus (failing in middle), labrum, base of mandibles, and very narrow lateral face-marks ending as a fine line scarcely as high as antennæ, all yellow; scape black; flagellum red, basal half black above; third antennal joint nearly as long as fourth; thorax entirely black except that the tubercles are coppery-red; pubescence of head and thorax abundant, dull white, about the same color throughout; legs red, basal half of anterior femora beneath, middle femora behind except apex, and hind femora at sides and beneath, black; tegulæ light ferruginous, shining; wings fairly clear, dusky at apex; nervures and stigma dark brown; second submarginal cell narrow, higher than broad; third about or nearly as broad above as second, but greatly broadened at base; basal nervure a fair distance basad of transverso-medial; abdomen narrow, light red; basal half of first segment black; hind margins of first and second segments narrowly blackened, especially at sides; second and third segments each with a pair of large light yellow spots, wide apart and not pointed mesad; apex with a shallow emargination; venter red, more or less clouded with blackish, and black at base.

Hab.—Corvallis, Ore., May 20, 1899 (*Cordley*). A female from Corvallis, April 15 (*Cordley*), is referred to *N. rhodomelas* with much hesitation. It is red, and agrees with *rhodomelas*, and differs from *grayi*, in having much black at the base of the first abdominal segment. The second submarginal cell is very different from that of *rhodomelas*, being greatly broadened at the base, not essentially different from that of *grayi*. The abdomen is oval, quite broad, with round yellow spots on the sides of the second segment. The region just above the antennæ is black.

Nomada washingtoni, sp. n.

♀.—Length about $8\frac{1}{2}$ mm.; a bright ferruginous species, superficially similar to *grayi*, but with a shorter, more shining abdomen. It differs also by its considerably broader face, the orbits hardly converging below, and the peculiar third submarginal cell, which is high and narrow, the outer side regularly curved. The wings are dusky, the stigma is dark, and the basal nervure is a long distance basad of the transverso-medial; antennæ wholly red, except that the scape has a black mark above; third joint very much shorter than fourth; middle of front with a large black patch; mesothorax with a median black

stripe, but that on metathorax merely indicated on lower part; abdomen very broad; hardly any black at base of first segment; second with a small round yellow spot on each side; first ventral segment with a suffused black fish-tail mark; legs red, middle and hind femora more or less black at base beneath; first joint of hind tarsi blackened.

Hab.—Washington State (further particulars unknown), one in Coll. of Acad. Nat. Sci. Phila.

Nomada physura, sp. n.

♂.—Length 9 mm.; head and thorax black, very densely punctured, hairy, the dorsal hairs orange-ferruginous, the others white; facial quadrangle broader than long, especially above, the orbits conspicuously converging below; mandibles (except tips), labrum, clypeus, and lateral face-marks (narrow, and ending in a very fine point about level of antennæ), lemon-yellow; antennæ long, third joint considerably shorter than fourth; scape stout but hardly swollen, hairy, reddish-yellow in front and black behind; flagellum bright ferruginous, basal half blackish above; upper margin of prothorax, spot on anterior part of pleura, tubercles, tegulæ and scutellum, bright ferruginous; tegulæ strongly punctured; wings fairly clear, dusky at apex, nervures dark brown, stigma ferruginous; second and third submarginal cells broad; basal nervure a moderate distance basad of transverso-medial; legs bright red, coxæ largely black; front and middle femora at base beneath, and hind femora beneath and behind except apex, black; spurs light ferruginous; abdomen narrow-fusiform, bright red; basal half of first segment black; apical margin of first four segments very narrowly blackish; second and third segments with rounded lateral yellow spots, those on second much the largest; apical plate narrow, truncate, feebly notched; venter bright orange-ferruginous, with the base black and four narrow blackish transverse bands.

Hab.—"Nevada"; no other particulars known. One in Coll. Acad. Nat. Sci. Phila. It does not seem probable that this is the male of *N. rhodalis.*

Nomada schwarzi, sp. n.

♂.—Length 8½ mm.; allied to *bella* and *cuneata*, but distinguished by the characters given in the table. Antennæ bright red, scape and first four joints of flagellum partly black above; mesothorax very coarsely punctured, with the lateral margins and two stripes on disk, dark dull red; scutellum and postscutellum rather bright red; pleura with a red spot in front, and dot beneath wings; tubercles, tegulæ and narrow upper border of prothorax red; legs red, blackened basally; wings clear, with clouded apex; stigma dark reddish-brown; basal

nervure a fair distance basad of transverso-medial; abdomen rather light red, nearly basal half of first segment black; large yellow marks on second and third segments elongated and pointed mesad; apical segments suffused with blackish; apex deeply emarginate; venter red, black at base, and with suffused blackish markings.

♀.—Length about 8 mm.; red; mesothorax with one black stripe; first abdominal segment with a pair of lateral black stripes diverging from the middle of the base, each deeply notched anteriorly; second submarginal cell very broad above. General characters much as ♀ *cuneata* (see table).

Hab.—Veta Pass, Colo., June 28, "collection C. V. Riley"; in National Museum. This, the type specimen, is a male. Two females in the National Museum are assigned here on the basis of probabilities; they are from the Baker collection, marked Colorado, number 1,871.

Nomada schwarzi contractula, subsp. n.

♂.—Length 8 mm.; distinguished principally by the characters given in the table. The greater part of the mesothorax is red, and the pleura has a large transverse red patch. The abdomen is broad, dark red and distinctly punctured. Stigma dark; third submarginal cell with the outer bend low down; apical plate of abdomen only very feebly notched.

Hab.—Beulah, N. M., July, 1902. 1 ♂. (*Cockerell.*) Perhaps a distinct species.

Nomada perplexa, Cresson.

Mr. Viereck has examined Cresson's types, and finds they represent a *Gnathias* 8 mm. long; the scape in front dark ferruginous to dark brown and blackish, pale ferruginous or yellowish-ferruginous at base; no yellow spots on fifth abdominal segment; basal nervure a considerable distance basad of transverso-medial; third antennal joint little or not distinctly less than fourth. The species is a rather obscure but perfectly valid one. I have before me numerous specimens collected by Mr. Viereck, marked Lehigh Gap, Pa., males June 25 to 29, females July 1 to 21 (some of the latter collected by Mr. Rehn); Montgomery county, Pa., June 21, ♀; Castle Rock, Pa., July 18, 1901, ♀.

Nomada rhodalis, sp. n.

♀.—Length about 8½ mm.; robust, abdomen broad-oval, shining; whole insect bright ferruginous, except a few black markings, viz., a stripe on prothorax, mark between wings and scutellum, and a spot in front of and above middle coxæ; no black at base of abdomen; palpi darkened, with conspicuous light rings at the sutures; face broad;

antennæ long, third joint scarcely shorter than fourth; tegulæ ferruginous, conspicuously punctured; wings dusky, especially at tips; second submarginal cell scarcely broader above than third; basal nervure a long distance basad of transverso-medial; nervures very dark; stigma small, ferruginous; first ventral segment of abdomen with a longitudinal black patch.

Hab.—Nevada (no details known). One in Coll. Acad. Nat. Sci. Phila.

Nomada bella, Cresson.

N. bella was based on the male; Robertson in 1902 stated that *N. maculata* was the female of the same species. So far as I am able to make out, this is correct; and Mr. Viereck, after examining Cresson's types, writes: "I think *bella* is very likely the other sex of *maculata*." As I have indicated in the table, the species presents some variation, which is partly geographical; but I am not at present able to distinguish more than one species in the material studied. It is curious that the females from the northwest, where one expects melanism, are paler than those from the northeastern States. *N. bella* flies from the latter part of April, through May, but apparently is over by June in most localities. In the series before me the males (*bella*, Cresson) are from Philadelphia, Pa. (Viereck); Riverton, N. J. (Viereck); Nyack, N. Y. (Zabriskie); New Hampshire (Baker collection, number 1,879); Polk county, Wis. (Baker); Michigan (Gillette); and Baldwin, Kans. (J. C. Bridwell). The females (*maculata*, Cresson) are from Franklinville, Pa. (Fox); Lehigh Gap, Pa. (Viereck); Indiana (Baker collection, numbers 1,876, 1,878); New Hampshire (Baker collection); Glenora, British Columbia (Wickham); Corvallis, Oreg. (Cordley); and Olympia, Wash. (Kincaid). It seems remarkable that a species found in Indiana and Kansas should fail to occur in Mr. Robertson's district in Illinois, but he has never met with it. This fact illustrates the danger of error in making broad statements about distribution. I find I have a single male collected by Prof. Kincaid at Seattle, Wash., June 25, 1897. This is much later than any of the dates on eastern specimens, but the insect appears to be a genuine *bella*.

Nomada cuneata, (Rob.).

In 1899 (*Entomologist*, p. 156) I commented on the geographical difference in size in the so-called *N. maculata*, and just before Robertson's recent paper appeared I had concluded that the small form ought to be separated. I am therefore very willing to recognize *N. cuneata* as valid. It does not always live apart from *N. bella* (*maculata*), but invades the territory of the latter in Kansas and Pennsylvania. *N.*

cuneata flies during April, May and the early part of June, its flight being coincident with that of *bella*. My latest date is June 5, Edge Hill, Pa. The localities represented are: Edge Hill, Pa., ♀ (Viereck); Ashbourne, Pa., ♂ (Viereck); Montgomery county, Pa., ♀ (Viereck); Lehigh Gap, Pa., ♀ (Viereck); New York State (Baker collection, ♀, No. 1,868; ♂, No. 2,168); Indiana (Baker collection, ♀, Nos. 2,002 and 2,040; ♂, No. 1,876); Illinois, ♂ (Robertson; sent years ago as *maculata*); Lincoln, Neb. (Bruner); Cedar Bluffs, Neb. (Bruner). Six males from Polk county, Wis., and one from New York State, all from the Baker collection, represent forms differing from *N. cuneata*, as is indicated in the table given above. They appear to constitute two geographical races, perhaps species; but as they are reddened by cyanide, and I have no females which belong to them, I leave them without names.

Nomada albofasciata, Smith.

I have before me one male from Polk county, Wis. (Baker), and one from New York State (Baker coll., 2,168), both from the National Museum. The species was described from Canada. It is separable from *cuneata* by the bands of the abdomen being creamy-white instead of yellow, but it is extremely closely allied. When the abdomen is retracted, the bands on the third and following segments become partly or wholly hidden. The length of the insect is 6½ to 7 mm.

Nomada louisianæ, sp. n.

♀.—Length 8 mm.; dark red; antennæ entirely red, third joint nearly as long as fourth; a short keel between antennæ; some black between ocelli and between antennæ; mesothorax with a single black band; metathorax with a black diamond; apical margin of wings strongly dusky; stigma dark reddish-brown, nervures fuscous; abdomen without spots or bands of yellow; four black spots at sides of base of first segment; pygidium shovel-shaped. Known from *N. cuneata* by its narrower, more cylindrical abdomen, and narrower face.

Hab.—Louisiana (Baker coll., No. 2,420), one in National Museum. With regard to the Bakerian numbers, it is well to state that they represent particular lots of specimens, captured at the same place, but not particular species. Hence different species often bear the same number.

Nomada carolinæ, sp. n.

♀.—Length about 7½ mm.; red; region above antennæ, region about ocelli, broad band on mesothorax, broad band on metathorax, much of prothorax, and region between wings and middle and hind coxæ, all

lack; cheeks black behind; abdomen long-oval, extreme base and ıore of sides of first segment black; second segment with large subyriform (pointing mesad) yellow spots; spots on third segment presnt, but concealed by the retraction of the segment; antennæ wholly :d, third segment almost as long as fourth; postscutellum dull orange; gs clear red, not blackened, except that the coxæ are largely black; eneral color of insect conspicuously lighter than in *N. cuneata.* Lat:al black mesothoracic bands may be more or less indicated anteriorly.

Hab.—North Carolina, collector unknown. Two in Coll. of Acad. at. Sci. Phila. Perhaps only a race of *cuneata*, but obviously different ı appearance from any in my large series of the latter, and also from very different region.

The remaining species discussed in this paper have simple mandibles. he two following are comparatively large red and yellow species, supercially resembling *N. zebrata* and *N. vincta.*

omada coloradensis, sp. n.

♀.—Length about 11 mm.; general build as in *zebrata*, except that ıe head and thorax are somewhat smaller; head, thorax and legs right ferruginous without yellow, and with little black; abdomen ferıginous, sculptured as in *zebrata* but less closely, leaving the surface ıining; first segment with black at extreme base, half-way along des, and in basal sulcus, but no yellow; second and third segments ith very large pyriform bright yellow marks pointed mesad; fourth gment with a yellow band, broadly emarginate in the middle anteorly, and large lateral yellow spots; fifth segment with two yellow ›ots; venter ferruginous, immaculate. Labrum with a slight median ngitudinal carina, and a small red tubercle on apical margin; facial uadrangle square; a very little black about ocelli and on inner side of ntennal sockets; cheeks all red; antennæ entirely red, third and ›urth joints subequal, flagellum robust; mesothorax very densely unctured, with no black band; metathorax with a black band, broken n apical part of enclosure; enclosure very large; sides of metathorax ›mewhat angled, not hairy (in *vincta* they are also bare, but in *zebrata* ›vered with pale golden hairs); tegulæ shining, rather sparsely puncured; wings strongly yellowish, stigma ferruginous, nervures ferruinous on basal half of wing, fuscous on apical; second submarginal ell very broad above, third with its outer margin bent almost to a ight angle, its apex greatly narrowed; basal nervure a moderate disance basad of transverso-medial; hind tibiæ rough with black bristles; ›ygidium broad shovel-shaped.

Hab.—Colorado, bearing numbers 566 and 34; no further particulars

known to me. One in Coll. of Acad. Nat. Sci. Phila. I suspect that it came from Prof. Gillette.

Nomada wheeleri, sp. n.

♀.—Length 9½ mm.; robust, red, yellow and black; eyes purplish-gray; face slightly narrowed below; clypeus (except lateral spots), labrum, basal half of mandibles, anterior orbits broad below and extending more narrowly to top of eyes, and basal third of posterior orbits narrowly, all red; other parts of head black; front and vertex with very coarse punctures; labrum closely and coarsely punctured, with about four minute red denticles on middle of anterior margin; antennæ rather short, third joint longer than fourth; first three joints bright red, the rest darker, the apical half of the flagellum thickened and quite dusky; mesothorax with dense extremely large punctures, its color dull red, the anterior margin narrowly black, and a black median band on its posterior two-fifths; the prominent upper margin of prothorax, tubercles, the strongly bilobed scutellum except its median suture, and the postscutellum, yellow; pleura red with a yellow spot; metathorax entirely black, the enclosure short, the sides heavily bearded with yellowish-white hair; tegulæ red, large; wings nearly clear, dusky on apical margin, stigma small, ferruginous, nervures brown; second and third submarginal cells of equal breadth above, third scarcely angled outwardly; basal nervure meeting transverso-cubital; legs red, anterior coxæ with an apical point, hardly to be called a spine; abdomen closely and minutely but distinctly punctured; first segment red, clouded with black at base, and with two large transverse yellow marks; second red, almost covered by a dull yellow band which is very deeply and broadly emarginate in front; third yellow with the apical margin fuscous; fourth yellow, black at extreme base, and very narrowly fuscous on apical margin; fifth yellow; pygidium rounded at end; venter ferruginous, with a semilunar yellow mark on fourth segment.

Hab.—Texas (*Belfrage*). One in U. S. National Museum. Named after Prof. W. M. Wheeler, who has made such valuable contributions to the knowledge of Texan entomology. The densely (though very coarsely) punctured pleura, the markings of the face and abdomen. and the less robust form, distinguish this from *N. belfragei*, to which it is allied. The species belongs to *Micronomada* (syn. *Cephen*, Rob.), and it is also allied to *N. fervida*, Smith, which occurs in Florida and Georgia.

Nomada lehighensis, sp. n.

♀.—Length about 7½ mm.; ferruginous; area just above antennæ, region of ocelli, cheeks behind, anterior margin of mesothorax and three longitudinal bands (the lateral ones more or less evanescent), band on metathorax and broad band from wings to middle coxæ, all black; first segment of abdomen with lateral wedge-shaped blackish marks, but not black across the middle; second and third segments with distinct but small and round lateral yellow spots; fourth with sometimes four very small and indistinct yellow spots; fifth without yellow; venter ferruginous, darker in the middle, but immaculate. Mandibles simple; lower corners of face with a small yellow spot, not always evident; head broad, facial quadrangle a little broader than long; antennæ entirely ferruginous; fourth joint distinctly but not greatly longer than third, and a very little shorter than twelfth; tegulæ ferruginous, punctured; legs red, the basal parts suffused with blackish; wings rather dusky, especially on apical margin; stigma very dark ferruginous, nervures fuscous; second submarginal cell with its lower inner angle produced; basal nervure a short distance basad of transverso-medial; pygidial plate with gently rounded sides, the apex subacute.

♂.—Similar to that of *N. sayi*, Rob.; but face broader; the slender scape ferruginous in front; third antennal joint nearly as long as fourth, which is shorter than in *sayi;* basal nervure very near to transverso-medial (far basad of it in *sayi*); abdomen darker, with the yellow spots not pointed mesad; whole insect less slender.

Hab.—Lehigh Gap, Pa., July 1, 1897, ♀; July 11, 1900, ♀; July 21, 1902, ♀; June 29, 1901, ♀; June 25, 1901, ♀, ♂; June 30, 1901, ♂. Collected by Mr. Viereck. In one female the abdomen is without yellow spots; in another there is only one black band on the mesothorax.

N. lehighensis is a good deal like the Californian *N. atrofrontata*, Ckll., but among other differences the mesothorax of the latter is much more finely punctured. From the Oregonian *N. ultima*, Ckll., *N. lehighensis* is easily separated by its yellowish-red abdomen, with none of the coppery luster of *ultima*.

Nomada sayi, Rob.

I have an Illinois male from Mr. Robertson. Mr. Viereck has taken the species as follows: Clementon, N. J., June 2, 1901, ♀; Edge Hill, Pa., females, May 20, 1900, April 28 and May, 5, 1901; Philadelphia, Pa., June 22, 1899, ♀; Ashbourne, Pa., May 24, 1901, three males (all with scutellum red) and one female. It appears from these dates that *N. sayi* flies earlier than *N. lehighensis*.

Nomada valida, Smith.

♀.—Length 8 to 9 mm.; mandibles simple; abdomen dark chestnut-red, basal half of first segment black right across; second submarginal cell broad above; basal nervure a very little basad of transverso-medial, or sometimes a fair distance basad. I find the markings just as described by Smith, except that only the very narrow hind margin of the clypeus is black.

I recognize *N. valida* in three females from the Baker collection, in the National Museum. Two are labelled "Canada, 1872," and the other "New York, 1868." The scutellum is convex, bristly, but very slightly bilobed. The fourth antennal joint is a little longer than the third. The insect is evidently close to *N. simplex*, Rob., but it lacks the spots on the abdomen. *N. valida* is separated from *N. corvallisensis* by its larger size, distinct parapsidal grooves and dark bristles on scape; from *N. clarkii* by its much darker coloration, and smaller wings. It is, however, a close ally of *N. clarkii*, and when specimens have been collected right across the northern part of the continent, it may be necessary to reduce *clarkii* to subspecific rank.

A male marked "Canada, 1872," may belong to *valida*. It is 9½ mm. long; face silvery-hairy; clypeus, supraclypeal mark and rapidly narrowing lateral marks, yellow; scape rather stout, yellow tinged with red, flagellum entirely red; thorax very dark, but the bifid red marks on mesothorax are faintly indicated; very narrow hind margin of prothorax yellowish; scutellum and postscutellum mainly red; pleura with an obscure dull yellow spot, and a smaller and more obscure red one higher up; metathorax all black, with coarse vermiform rugæ at base; scutellum more prominent than in ♀, and with white instead of fuscous hairs; tegulæ pale yellowish-testaceous (deep red in ♀); third submarginal cell as broad above as second (narrower in ♀); basal nervure a fair distance basad of transverso-medial; abdomen ferruginous, basal half of first segment black; first segment with a rather narrow interrupted yellow band; second with a very broad yellow band, having only a linear median interruption; remaining segments with yellow bands, more or less notched behind laterally; apical plate deeply notched; venter dark ferruginous, with a large yellow spot at apex. The labrum is yellow, with a minute red denticle in the middle. The legs are red, the hind femora black beneath. The dentate labrum of this male allies it with *N. armata*, H.-S., which European species is said to occur, like *valida*, in Nova Scotia.

The large size of this male ("Canada, 1872") and the characters of the wings, tegulæ, metathorax, etc., make its identity with *valida* so

questionable that I believe least confusion will occur if it goes for the present under another name. It may be called *N. armatella*, sp. n.

There is a second species in Canada (Baker coll., No. 2,174, in National Museum) which I had at first confused with *N. armatella;* the male is about 10 mm. long, and differs from *armatella* thus:

N. armatella, sp. n.	*N. bethunei*, sp. n.
Denticle on labrum evident.	Denticle rudimentary.
Posterior orbits black.	Posterior orbits broadly red.
Front and vertex black; a red spot above each eye.	Front and vertex largely red.
Scape cylindrical.	*Scape swollen.*
Third antennal joint longer than broad.	Third joint broader than long.
Pleura with hardly any red.	Pleura with much red.
Base of metathorax coarsely wrinkled.	*Base of metathorax rugulose.*
Metathorax entirely black.	Metathorax with four red spots.
Basal nervure considerably basad of transverso-medial.	Basal nervure very little basad.
Yellow band on second abdominal segment with only a linear interruption.	Band broadly interrupted.
Apical plate very narrow.	*Apical plate very broad.*

The characters italicized are important; the others may not have specific value. *N. bethunei* is named after the Rev. C. J. S. Bethune.

Another species with a denticle on the labrum is *N. depressa*, Cresson, if I have correctly identified as such a specimen collected by Mr. Viereck at Lehigh Gap, Pa., June 30, 1897. It is a female, and has the large semilunar depression on the fifth abdominal segment as described in *depressa*. It is about 9 mm. long. The second transverso-cubital nervure is incomplete in both wings. An allied species, described below, occurs in Oregon.

Two males collected by Mr. Viereck at Philadelphia, Pa., May 2, 1897, have the mesothorax marked with dark red just as in *N. armatella*, and also possess a very rudimentary spine on the labrum, only visible because of its reddish color. I was almost ready to think these a varietal form of *armatella*, until I observed that they had bidentate mandibles, and belonged to *Gnathias*. As a matter of fact, they are a varietal form of *N. bella*, parallel to the variety of *N. perplexa* cited in the table of *Gnathias*. Typical *bella* also has a minute spine on the labrum, or rather a rudiment of a spine.

Nomada volatilis, Smith, described from Canada, is, I believe, a form of *N. bella*. We are not informed whether it has bidentate mandibles,

and I thought at first it might be *N. armatella;* but the following characters indicate *bella* rather than *armatella:* Supraclypeal mark absent; antennæ fulvous beneath (nothing said about yellow on scape); tegulæ ferruginous; abdominal bands interrupted; apical margins of ventral abdominal segments fusco-ferruginous.

Nomada hoodiana, sp. n.

♀.—Length about 9 mm.; ferruginous-red, the color of the abdomen bright; facial quadrangle square; cheeks with the anterior half red and the posterior half black; a little blackish about bases of antennæ, sending lines downward to middle of sides of clypeus; ocelli on a small black patch; antennæ entirely red, except for a small black mark on scape above; third joint subequal with fourth; mesothorax with one black band; tubercles rather coppery, surrounded by black; enclosure of metathorax entirely red, minutely wrinkled at base; tegulæ yellowish-ferruginous; wings dusky along the veins; stigma dark reddish; second submarginal cell broad, third greatly narrowed above; basal nervure far basad of transverso-medial; legs red; first four femora with a black mark at base beneath; hind femora with much black suffusion beneath; abdomen of the comparatively long and narrow type; base of first segment black, with four reddish spots, the anterior edge of the black concave, and wavy in the middle; second segment with small and obscure suffused yellow lateral spots; fifth segment with a large semilunar velvety depression; pygidium very broad; venter red, a black fish-tail mark on basal segment.

Hab.—Mt. Hood, Ore.; collector unknown, (Coll. Acad. Nat. Sci. Phila.). The depression on the fifth segment is nearly twice as wide as in the Pennsylvania species I take for *N. depressa.*

The species in the following table all have the abdomen strongly punctured, the punctures round and distinct. They belong to *Micronomada* and *Centrias.* Those marked (D.) are placed from the description, specimens not being available:

Females.

Abdomen red, without light bands, ... 1.
Abdomen with light bands, ... 2.
1. Flagellum clear red, ... *martinella*, Ckll.
   Flagellum strongly dusky, ... *americana*, Kirby,
2. Mesothorax red, basal half of abdomen at least largely red, . 3.
   Mesothorax black, with little, if any, red, ... 4.
3. Basal half of abdomen bright red; apical half with white bands, *rubicunda*, Oliv.
   Abdomen heavily marked with yellow, the two halves not conspicuously different, ... *wheeleri*, Ckll.

4. Basal half of abdomen not red, ... 5.
First abdominal segment red; clypeus red, lateral face-marks white, ... *snowii*, Cr. (D.).
Abdomen red with white bands, ... *ridingsii*, Cr. (D.).
5. Mesothorax with obscure reddish stripes; size large, abdomen very broad, ... *erigeronis*, Rob.
Mesothorax without any red; size smaller, abdomen not so broad, ... 6.
6. Legs largely yellow; clypeus yellow, ... *formula*, Viereck.
Legs red, ... 7.
7. Mesothorax with the punctures well separated, ... 8.
Mesothorax with the punctures extremely dense, ... 9.
8. Markings creamy-white, ... *vierecki*, Ckll.
Markings lemon-yellow, ... *putnami*, Cr. (D.).
9. Clypeus red, ... *modesta* var. *vegana*, Ckll.
Clypeus black, ... 10.
10. Metathorax with yellow spots, ... *modesta*, Cr.
Metathorax without yellow spots, ... 11.
11. Lateral face-marks white, ... *heiligbrodtii*, Cr. (D.).
Lateral face-marks yellow, ... 12.
12. Punctures of mesothorax smaller, ... *texana*, Cr.
Punctures of mesothorax larger, ... 13.
13. Flagellum black beneath, . . . *modesta* var. *rivertonensis*, Ckll.
Flagellum red beneath, ... *neomexicana*, Ckll.

Males.

Apex of abdomen entire; supraclypeal mark surrounded by black, *lippiæ*, Ckll.
Apex of abdomen notched, though sometimes feebly, ... 1.
1. Flagellum with a light median area, on each side of which is black, ... 2.
Flagellum ordinary, not so colored, ... 6.
2. Tegulæ pale yellow or whitish, ... 3.
Tegulæ deep ferruginous, ... 5.
3. No supraclypeal mark, ... *scitiformis*, Ckll.
Supraclypeal mark present, ... 4.
4. First abdominal segment largely red, without light markings, *sophiarum*, Ckll.
First abdominal segment black, with a narrowly interrupted cream-colored band, ... *scita*, Cr.
5. Ground color of abdomen nearly all red, *americana* var. *dacotana*, Ckll.
Ground color of abdomen red basally, otherwise black, *americana*, Kirby.
6. Metathorax with yellow spots, ... *modesta*, Cr.
Metathorax without yellow spots, ... 7.
7. Size larger; apex of abdomen very deeply emarginate; no supraclypeal mark, ... *crassula*, Ckll.
Size smaller; apex of abdomen not so deeply emarginate, . 8.

8. Ventral surface of abdomen with two light bands, ... 9.
   Ventral surface of abdomen dark, with at most minute light marks, ... 10.
9. Markings yellow, ... *crucis*, Ckll.
   Markings white, ... *vierecki*, Ckll.
10. Labrum with a black spot; wings nearly clear, with a dark apical cloud, ... *neomexicana*, Ckll.
    Labrum without a black spot; wings very dark, *tiftonensis*, Ckll.

Nomada modesta, Cresson.

Originally described from Maine and Illinois. Robertson does not find it near Carlinsville, Ill., however. The specimens before me are from Riverton, N. J., both sexes (*Viereck*); Dakota, one ♀; Colorado, one ♂. The Riverton specimens were taken August 3. A female from Anglesea, N. J., was taken by Mr. Viereck, August 8, 1901.

Nomada modesta var. rivertonensis, n. var.

This is really a mutation, lacking the spots on the metathorax; a specific character in other cases. One ♀, Riverton, N. J., August (*Viereck*).

Nomada modesta var. vegana, n. var.

♀.—Rather small; clypeus ferruginous. Apparently a geographical race. Las Vegas, N. M., July 12, 1899 (*A. Garlick*); Colorado Springs, Colo., middle of July (*Cockerell*). The subgenus *Micronomada* was founded on this form.

Nomada tiftonensis, sp. n.

♂.—Length about 7 mm.; in sculpture and markings like a small *modesta*, but lateral face-marks receding from orbits at end; metathorax all black; hind femora black behind except at base and apex; and ventral surface of abdomen without yellow marks. Third antennal joint longer than fourth; second submarginal cell very broad above. One specimen has the supraclypeal mark subobsolete.

Hab.—Tifton, Ga., collector unknown. Two in Coll. of Acad. Nat. Sci. Phila.

Nomada crassula, sp. n.

♀.—Length about 9 mm.; black with yellow markings, general appearance like *modesta*, but abdomen broader, and sculpture of mesothorax and vertex considerably coarser. Face-marks pale yellow, lateral marks shaped as in *modesta*, but there is no supraclypeal mark, and a band of black runs down each side of clypeus, while there is a black triangle, cutting into the lateral marks, on the lower part of the anterior orbital margin. Labrum densely pubescent; antennæ as in *modesta*,

xcept that the scape is slender, punctured and ferruginous; tegulæ :rruginous with a yellow spot; pleura black with an oval yellow mark n posterior part; yellow collar, tubercles, scutellum and postscutellum s in *modesta;* median depression of scutellum ferruginous; metathorax ithout yellow spots, its pubescence very short and conspicuously lumose; wings dusky, very dark at apex; stigma ferruginous, nervires rather pale fuscous; second submarginal cell very broad above; hird narrow, its outer margin gently curved, greatly narrowed to mar- inal; basal nervure meeting transverso-medial; legs red; hind femora lack behind and beneath except at extreme apex and base; hind tibiæ vith a large yellow apical spot; hind coxæ black with a yellow mark; nterior coxæ black with a red apical spot, and long spines; abdomen lack; apical half of first segment fuscous, with an entire yellow band, vhich is indented on each side in front; second segment with a road yellow band; third and fourth with narrow bands, interrupted n the middle, and deeply indented (or interrupted) on each side osteriorly; fifth with a narrow yellow band, and lateral spots; apical late broad, black, very deeply notched; venter entirely black.

Hab.—Louisiana, one (No. 2,563) in U. S. National Museum. The hird antennal joint is longer than the fourth. The following Cresonian species have been examined by Mr. Viereck, and found to ave, like *N. crassula*, the third joint longer than the fourth, and the asal nervure meeting transverso-cubital: *belfragei*, *zebrata*, *ridingsii*, *nodesta*, *cubensis*, *krugii*, *tibialis*, *limata* and *scita*. The same is true lso of *N. formula*.

NOMADULA, subg. n.

Type *N. americana*, "Kirby," Robertson, Ckll. Distinguished by he peculiar male antennæ, the two sexes quite differently colored, he strongly punctured abdomen, and the spined anterior coxæ. Inludes *N. americana*, *N. martinella*, *N. scita*, *N. scitiformis*, *N. erythrohroa* and *N. sophiarum*. This is a compact group, quite distinct from *'entrias*, the type of which is *N. erigeronis*. *N. erythrochroa* is much ke *martinella*, but larger, and with the abdomen much more finely unctured, and the eyes more converging below.

omada sphærogaster, sp. n.

♀.—Length about 8 mm.; black and yellow, with the legs largely ·d; form very broad (like *erigeronis*), the abdomen spherical seen om above. The general appearance is so like *N. crassula* that I ought at first it might be the female of that species; but this cannot :, as the anterior coxæ are not spined, and the punctures of the abdo-

men, though distinct, are merely little semilunar depressions. Head broad, facial quadrangle broader than long; scape and face with black bristles; cheeks entirely black, covered with grayish hair; mandibles except tips, labrum (which has a slight tubercle), clypeus except upper part, and a transverse flame-like mark coming from the lowest part of anterior orbital margin, yellowish-ferruginous; a minute red spot at the summit of each eye; antennæ rather long, third joint shorter than fourth; flagellum thick, dark reddish (the first joint brighter), as also is the scape; thorax rather abundantly clothed with dull grayish hair; mesothorax entirely black, extremely closely punctured; metathorax black, with two small yellow spots on the enclosure; scutellum with two large oval yellow spots; postscutellum black; pleura black; upper edge of prothorax, tubercles and tegulæ yellow; wings dusky, but not extremely dark, stigma and nervures rufo-fuscous; second submarginal cell broad above; third very broad below, its outer margin angled; basal nervure a short distance basad of transverso-medial; femora black, red at apex; tibiæ and tarsi red, the tibiæ more or less marked with yellow; abdomen black, with a broadly interrupted yellow band on first segment, a broad yellow band, not quite interrupted, on second, narrowly interrupted bands (more or less notched behind sublaterally) on third and fourth, and a large patch and lateral spots on fifth; pygidial plate very broadly rounded at end; venter black stained with red, especially on the second segment.

Hab.—Riverton, N. J., April 22 (*Viereck*). Mr. Viereck finds that the following Cressonian species have, like *N. sphærogaster*, the basal nervure a short distance basad of the transverso-medial, and the third antennal joint shorter than the fourth: *accepta*, *proxima*, *vicina*, *fragilis*, *dilucida*, *libata*, *parata*, *crotchii* and *crudelis*.

Nomada electella, sp. n.

♀.—Length about 7 mm., proportions ordinary; black, yellow and red. Head and thorax bare, extremely coarsely rugose; head black, with the clypeus, supraclypeal mark, rounded lateral face-marks not going above level of clypeus, labrum (which has a strong reddish spine), mandibles except tips, and a minute dot at the summit of each eye, yellow stained with ferruginous; antennæ rather long, first three joints rufous, the others dark reddish-brown, third joint very much shorter than fourth; thorax black, the upper margin of prothorax, prominent tubercles, scutellum and broad transverse band on pleura, yellow, the last tinged with red; tegulæ testaceous with a yellow spot; wings dusky, stigma and nervures fuscous; second submarginal cell small and narrow, narrowed almost to a point above; third broad below, its

outer side angled; basal nervure a little basad of transverso-medial (in *electa*, I learn from Mr. Viereck, it is far basad, in the manner of *Gnathias*); legs yellowish-ferruginous; anterior coxæ with a short and blunt, but very distinct, spine; abdomen shining, with minute shallow punctures, first segment impunctate; first segment with a cloudy reddish band; second with a very broad yellow band, broadly interrupted in the middle; third with a narrower band, the middle third of which is wanting, and which is deeply incised sublaterally behind; fourth with a band which has only a linear median interruption, but sublaterally is so deeply incised in front as to be almost interrupted; fifth with a very broad band, deeply incised sublaterally in front; venter dark ferruginous clouded with lighter, most of the second segment light.

Hab.—Georgia, one in Coll. Acad. Nat. Sci. Phila, mixed with *N. electa*, Mr. Viereck informs me. By reason of the spined coxæ, it is allied to *N. denticulata*, Rob.

Nomada robertsonella, sp. n.

♀.—Length 7½ mm.; bright ferruginous-red. This looks exactly like *N. erythræa* and *N. rhodosoma;* it differs from *erythræa* by having the abdomen without any coppery luster, the flagellum more slender, the third submarginal cell narrowed to a point above, and the second submarginal greatly produced at its lower inner angle. It differs from *N. rhodosoma* by having the third antennal joint only about half the length of the fourth, the third submarginal cell narrowed to a point above, and in the absence of a dark mark on the metathoracic enclosure. The basal nervure is a short distance basad of the transverso-medial; the first abdominal segment is without black, but has two faint dusky spots on each side of the basal half; the labrum has a distinct but small tubercle.

Hab.—Nevada, one in Coll. Acad. Nat. Sci. Phila., named after Mr. Charles Robertson. *N. rhodosoma*, Ckll., also occurs in Nevada; a single female from that State is in Coll. of Acad. Nat. Sci. Phila.

Nomada rhodosoma var. rhodosomella, var. nov.

♀.—Smaller, length about 6 mm.; red color not so dark, more yellowish; hindmost third of mesothorax with a black band; a black stripe extending upward from region of middle coxæ; a black patch on each side of scutellum; no dark mark on metathoracic enclosure; tegulæ paler and yellower; abdomen more shining.

Hab.—Colorado (*Morrison*). One in National Museum. Perhaps a distinct species. I do not know the male of this form. The colors and

markings of the Californian male *N. rhodosoma* are rather suggestive of the European *N. flavoguttata* (Kirby); at least, the abdomens are extremely similar, though the slender dark legs, very dark antennæ, reduced face-markings, and small black tegulæ of *flavoguttata* are quite different from those of *rhodosoma*. My material of *flavoguttata* is from Mr. Friese.

Nomada ruficornis, (L.).

A male sent by Mr. Viereck, from College Park, Md., April 10, 1898, is referred to this species, as it agrees with the description; but I have not been able to compare it with European specimens.

Nomada cressonii, Rob.

In the National Museum is a male from Indiana, with the Bakerian number 1,876.

Nomada kincaidiana, sp. n.

♀.—Length almost 9 mm, bright ferruginous. Much lighter, and with a narrower abdomen than *N. clarkii;* looks like *N. erythrochroa* or *N. rubrica;* differs from *erythrochroa* by its minutely roughened, slightly broader and darker abdomen; broader and less bilobed scutellum; broader face less narrowed below; black lines from antennæ to middle of sides of clypeus; smaller eyes; black patch before middle coxæ, and anterior coxæ without distinct spines. (In *erythrochroa* the anterior coxæ have very long spines.) The basal nervure is a moderate distance basad of the transverso-medial, while in *rubrica* they almost meet. The third and fourth antennal joints are both considerably shorter than in *rubrica*.

Hab.—Washington State, one in Coll. of Acad. Nat. Sci. Phila. Named after Prof. Trevor Kincaid.

VARIATION IN THE SNAIL-GENUS ASHMUNELLA.

BY T. D. A. COCKERELL.

Pilsbry's interesting remarks in these *Proceedings*, 1903, pp. 0, prompt me to offer some observations on *Ashmunella*. The *A. thomsoniana*, with its various races or subspecies, inhabits ountains near Santa Fé and Las Vegas, N. M., and has lately btained in sufficient quantities to afford statistical data which e expressed in curves or polygons. On June 20, 1903, Dr. abham and the present writer collected a large number of *A. niana cooperæ* on the Kin Kale Ranch, Pecos, N. M. (alt. about feet), and on plotting out the curves of shell-diameter, it was that the mode for *cooperæ* fell exactly between *thomsoniana* and *porteræ*, though there was a tendency toward a secondary coincident with the normal mode of *porteræ*. The following table the facts clear, and can be converted into a series of curves by ne who cares to do so:

ASHMUNELLA THOMSONIANA VARIETIES.

num Shell-er in millim.		11.5	12.	12.5	13.	13.5	14.	14.5	15.	15.5	16.	16.5	17.	17.5	18.
omsoniana. ooper's Mill Cooper).	Number of Specimens	9	49	50	51	7	1	1	..	..	..	..	..	..	..
. cooperæ. (Grabham Cockerell).		..	..	1	8	26	54	32	31	3	6	1	..	..	..
. cooperæ. débris of s River, at s (Cocke'l).		..	..	..	..	2	8	3	4	1	..	..	..	..	..
. porteræ. nares Creek Cooper).		..	..	..	..	1	3	13	16	10	5	6	..	..	1
. porteræ. , 8,000 feet rtin D. Cock-).		..	..	..	..	..	2	12	17	6	3	..	..	..	..

The Manzanares Creek *porteræ* represent a subvariety having the basal tooth with the outer denticle large and pointed, and the inner one quite rudimentary, a mere slight swelling; umbilicus large, broadly exposing penultimate whorl; parietal tooth strong. On the other hand, the Cooper's Mill *thomsoniana* have the basal tooth bifid as in *porteræ*, though they have the small size of typical *thomsoniana*. Whether they should be regarded as another distinct subvariety is uncertain, as so few specimens of the Santa Fé Cañon *thomsoniana* have been collected. It is to be remarked that size is not connected closely with altitude, regarding the whole series together. The large *porteræ* occupies the highest altitudes in the mountains near Las Vegas.

A single example from the débris of the Pecos river had no basal or outer denticle, and could easily have been mistaken for *A. ashmuni* (Dall).

Dr. Grabham and I dissected a number of the Pecos *cooperæ*, and found the epiphallus with a basal curve and double insertion of penis-retractor; spermatheca without any bulbous swelling at end, very variable in length, that of seven specimens measuring respectively, in mm., 29, 35, 22, 33.5, 35, 45, 31.

In the Pleistocene beds at Pecos, *Ashmunella* is represented by the very distinct form I named *pecosensis*, but the other shells found in the beds are identical with living forms, namely, *Pyramidula cooperi*, W. G. Binney, *P. cooperi depressa*, Ckll.,* *P. hemphilli*, Newc., *P. shimekii*, Pils.,* *Succinea avara*, Say,* *Vitrea indentata umbilicata*, Singley,* *Vallonia cyclophorella*, Ancey, *Pupa blandi*, Morse, *Limnæa humilis*, Say.* Those marked with an asterisk occurred only in some dark-colored beds which seem to be more recent than the red beds containing *A. pecosensis*. High up on the bluff Dr. Grabham found an apparently fossil shell of *A. t. cooperæ*, more strongly ribbed than the normal form, and thus tending toward *pecosensis*.

EXPERIMENTS WITH ANTS INDUCED TO SWIM.

BY ADELE M. FIELDE.

The behavior of ants often appears to originate in mental processes,[1] and the myrmecologist is perpetually lured to further experiment by a tantalizing expectation of ascertaining whether the cause of their action be psychic.

One afternoon in the summer of 1901 I inadvertently left, upon the base of a Lubbock nest in the laboratory, a score or two of ants, *Stenamma fulvum*, with a few of their larvæ and a little damp earth. Before the next noonday they had built with particles of the earth what looked like a roundish hut, not more than two centimeters long, with a doorway and a smoke-hole. Its outside shape was like that of the interior of one of their recesses in their wild nests. They had carried their larvæ into it, and had thereby screened them from light and from the wind. The air of the room was dry, and after a few hours the edifice disintegrated from the evaporation of its moisture.

These ants live under loose stones and among the roots of grasses, and do not build habitations on a surface. In opening scores of their nests, I have never found any similar structure. The little hut seemed to be evidence of a purposeful adjustment to new conditions.

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[1] In August, 1903, I left upon the bottom of a dish, surrounded by water in a larger dish, about seventy *Lasius latipes* workers, with fifty of their tiny cocoons, in two centimeters of earth, covered by a pane of orange glass ten centimeters long and eight centimeters broad. Such glass excludes, partially but not wholly, the ultra-violet light-rays always avoided by the ants. The earth extended about four centimeters beyond the glass. There was a morsel of food on the glass.

The ants had been undisturbed and unobserved for ten days, when I saw that they had nearly covered their roof-glass to the depth of about two millimeters with particles of earth. Many of the particles were half as long as the longest of the ants, and certainly heavier than any one of them, and could not have been laid on the glass without considerable effort on the part of the ants. This overlaying of the glass secured darkness for the workers and the young under the glass; and numerous runs with exits outside the edge of the glass had been made in the earth below, as is done in their wild nests under stones.

Thinking that the presence of the food on the glass might have influenced the deposit of the particles of earth, I removed the food to the end of the dish, washed the glass clean and replaced it. In a few days the ants had again covered the glass with like particles of earth. The work was always carried on in the night, and I did not witness its performance.

I made a similar arrangement of dishes, earth and glass for *Stenamma fulvum*, but these ants did not overlay their semi-transparent roof.

On August 29, 1903, I placed about fifty workers and three queens of this same species, with a half-teaspoonful of their pupæ, upon the base of the same Lubbock nest, in the same place in the same room,[3] hoping that they would again build a hut for their young during the ensuing night. I had many tens of times put *Stenamma fulvum* on this board, with their nest-earth and young, and they had never once escaped by swimming. The board is square, thirty-eight centimeters broad and four centimeters high. On its upper surface, about a centimeter from its edge, there is a channel having a flat bottom and vertical sides, two centimeters deep and from twenty-six to thirty millimeters wide. When this channel is filled with water an island about thirty centimeters square is formed by the central portion of the board. The ants were on this island, and their kind had never manifested ability to swim across the surrounding channel. These individual ants were habitants of a nest located at a considerable distance from any body of water, and they could have had no previous experience in swimming. I was therefore astonished on the following morning in finding that the ants, instead of building huts for their young, were carrying it to a crevice forty centimeters from the island, between the supporting table and the wall of the room. Two of the queens had gone, and one queen remained with a group of newly hatched callows. The labor of transporting the callows continued all day. I was curious to see how the queen would reach the crevice, as no ant travels far on any path before untraversed by her. As soon as the queen crossed the channel there was increased excitement among the ants. Several of the larger ones approached the queen, and one of them lifted her free from the edgeway and carried her to the crevice. All the remaining callows and the pupæ were likewise carried to the crevice, and at nightfall not an ant remained on the island, nor had any dead ants nor deserted pupæ been left in the channel. The exodus had occupied thirty hours.

When crossing the channel without a burden the smallest ants walked on the surface of the water. Heavier ones clawed the surface with the fore feet, walked with the middle pair and trailed the hinder ones. The degree of submergence greatly varied. When carrying a burden the ant swam with the legs wholly submerged, only the tarsi of the hinder ones being above the surface. The antennæ waved constantly and progress was very slow. Ants without burdens were from ten to sixty seconds in crossing the channel, while burdened ones

[3] These experiments were all made in the Marine Biological Laboratory at Woods Hole, Mass.

were from one to three minutes in struggling across. Sometimes the burdened swimmer became completely submerged, and when this happened she abandoned the burden, which floated, while the ant scrambled ashore. It was evident that the strength of the burdened ants was exhausted in reaching the edgeway, though they crossed in a straight line at right angles to the length of the channel. They had chosen, as the main crossing-place, the narrowest part of the channel, which was on the side of the board opposite the source of light, a northern window.

The next morning I thoroughly cleansed all parts of the board; turned the narrowest part of the channel to the opposite side, the northern; replaced it on the table; filled the channel with clean water; enclosed the board and an area half its size by a wall of plaster of Paris,[3] and set within the area one of my artificial nests, having an entrance four millimeters wide at a distance of fifteen centimeters from the board. On the island I then put some ant-food, three hundred workers, twelve queens, of whom five had long been deprived of antennæ, and a large teaspoonful of eggs, larvæ and pupæ. These ants were from the same colony as those that had gone to the crevice. The only ants in the arena were those on the island. My preparations were completed at eleven o'clock, and the first ant, a small adult worker, crossed the channel at a quarter before twelve o'clock. The second ant crossed, in another place, fifteen minutes later, and a third crossed after another half-hour. At three o'clock four more workers and three queens had crossed. The workers appeared to be seeking a habitation, and the queens were roaming on the edgeway. The first ant to enter the nest was a worker that chanced to find the small entrance at five o'clock, when many ants were prospecting in the area. Before the discovery of the dark, warm, humid interior of the new nest, and up to seven o'clock, no ant had returned across the channel.

The ensuing morning, at six o'clock, the ants were transporting young across the channel, mainly at its narrowest part, on the north side and toward the light. The eggs, larvæ and pupæ were piled on the south side of the island farthest from the light, and many ants were covering the pile with their bodies. Rescuers ran along the edgeway, or held to it with their hinder feet and stretched themselves over the water, as if with the purpose of securing flotsam. If they rendered aid to struggling swimmers other than the queens, it was merely by

[3] Forel's method of preventing the escape of ants.

assuring them in a touch of the antennæ that they were nearing a foothold.

Again, all the swimmers, with or without a burden, crossed the channel at right angles to its length. The swimming ants varied in length from five to seven millimeters, but the longest ones rarely repassed the channel, and the transits were made chiefly by ants from five to six millimeters long. They therefore had to swim at least twice their length after relinquishing one shore before they touched the other. They always lingered long on the brink, running to and fro; entered the water with much hesitation, and relinquished the shore with delay. I supplied as much water as was lost by evaporation, and kept the surface of the channel nearly level with that of the island and the edgeway. The concavity of the meniscus was slight, but capillarity always hindered the ant in her departure at one shore and somewhat accelerated her arrival at the other shore.

My first experiments were made with a view to ascertaining whether the ants laid each an individual track across the water, as is always done in traversing a solid.

Test a.—I selected ants that must have crossed the water at least once, because they were returning to the island, and when they had released their hinder feet from the edgeway, I took, with a pipette having a curved point, some drops of water from the surface of the water directly in front of the swimmer. Of thirty-one ants, twenty-one went immediately on their way to the island, and ten turned back to the edgeway. The taking of the water may not have caused all of the ten to turn back, since many other ants, finding the struggle of crossing too great, turned back when the water was untouched. Had the ants that continued on their way had a track previously laid on the water, it would probably have been destroyed by my action, and the twenty-one ants would also have turned back.

Test b.—Choosing an ant that was returning to the island, while she was in mid-channel, I passed a knife-blade five millimeters broad several times around the ant, penetrating the water to half its depth. Of ten ants thus encircled none turned back.

Test c.—I swept the floor of the room violently, raised much dust, and left the channel untouched during the ensuing twenty-four hours. I then counted the ants that crossed the channel during a half-hour, and found that twenty-one passages were made to the island and twenty-five away from the island. The latter number included four ants with burdens. With a shred of cloth I then brushed the dust

from the whole surface of the channel, being careful not to touch its shores. I then counted all the ants that crossed during the ensuing half-hour. Twenty passages were made to the island, and twenty-two were made from the island. The latter number included two burden-bearers. The close correspondence of numbers is explained by the fact that a few individuals among the ants do most of the work undertaken.

After the removal of the dust, with displacement of the particles of water over the whole surface of the channel, there was among the ants no action indicating either a difficulty in pursuing their routes, or a necessity for laying new tracks across the channel.

Test d.—I next considered only ants that had taken up a burden to carry away from the island, and when I saw one of these about to enter the water, I swept its surface with a little cloth broom that extended nearly across the channel. Fifteen burden-bearing ants crossed over water whose particles had just been disturbed to a depth of several millimeters. Their course was as direct and their time of crossing was as brief as that of burden-bearers whose path had not been thus swept.

These tests show that the ants did not depend on a previously laid track when they crossed the water. They evidently expected to find the water in the place where they had previously encountered it. Each ant pursued her laid track on the wood to the edge of the channel, and then orienting herself by something other than her track, she crossed and picked up her track on the opposite shore.

Bethe's well-known hypothesis, that the ants orient themselves through a polarization of the scent laid down by their feet, is surely inapplicable when the ants have no track, and keep to their bearings without one.

The difficulty of crossing the channel was greatly increased when the ant was forced to turn herself in the water in order to pursue her route, but even under this arduous strain most of the ants maintained their course.

Test e.—With a small knife-blade I swirled the water when the ant was in mid-channel, so as to turn the swimmer once or more around, leaving her with her head toward the shore from which she had just come. The results were as follows:

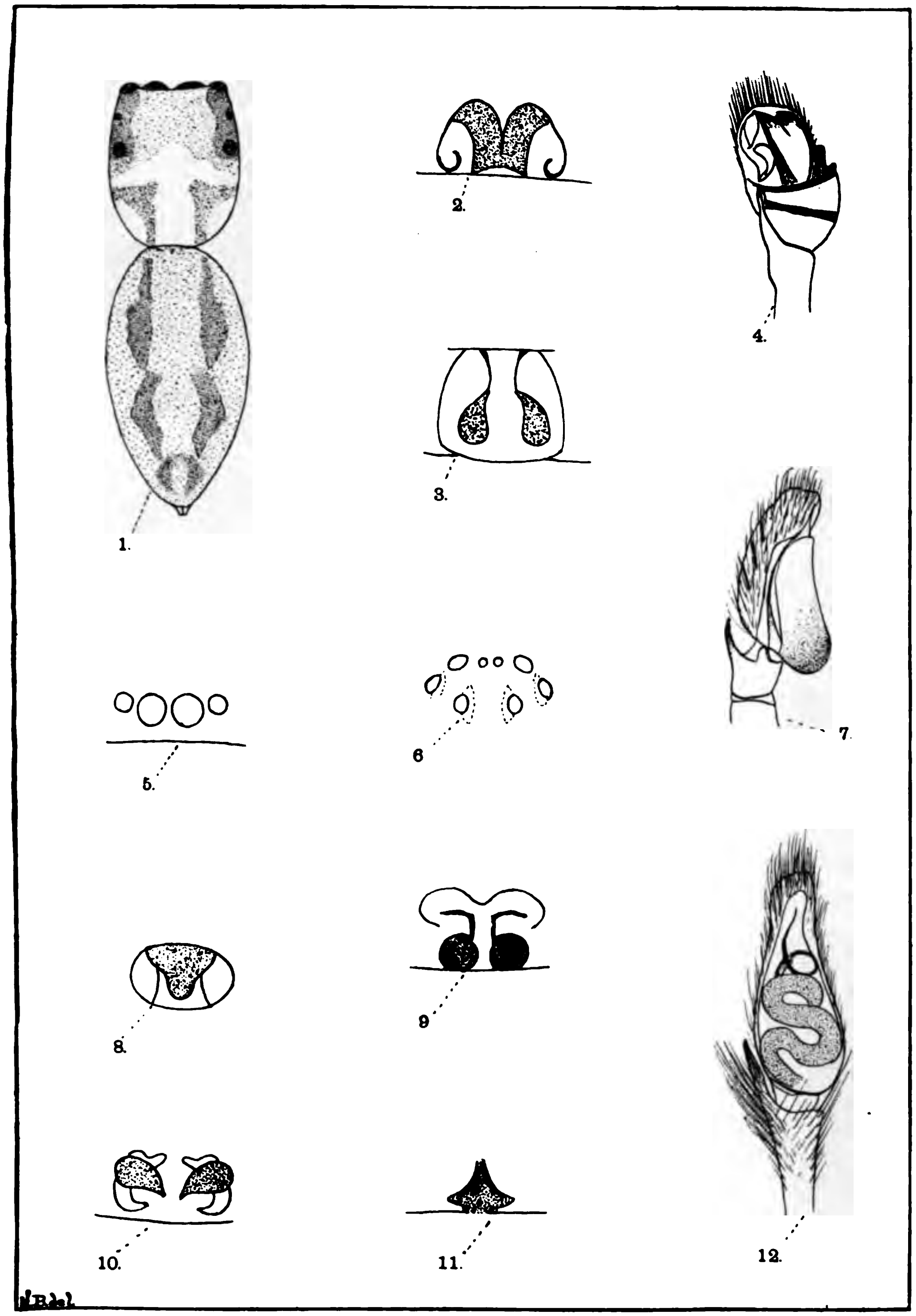
1. Of nineteen ants, without burden, on their way from the edgeway to the island, fifteen turned themselves in the water and swam to the island. Four failed in the effort to turn and went back to the edgeway.

curred, with the exception of about twenty newly hatched callows that had succumbed to the adverse conditions attending their hatching.[4]

[4] I append an irrelevant note concerning an abnormal form, uncommon in my ant-nests.

On August 25, 1903, I found, in one of my artificial nests of *Stenamma fulvum*, a recently hatched gynandromorphic ant, bilaterally asymetrical. The size, form, color and wings on the left side were those of the normal male, while the right side was in all respects like that of a normal worker.

Regarding such abnormal insects, Boveri (*Ueber Mehrpolige Mitosen als Mittel zur Analyze des Zellkerns*, 1902) presents the hypothesis that the first cleavage of the egg, marking the future axis of the body, occurred previous to fertilization; that the spermatozoan then entered one blastomere, producing on that side the female form, while the other blastomere developed parthogenetically into the male form.



BANKS. ARACHNIDA OF HAYTI.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x.
Mast.
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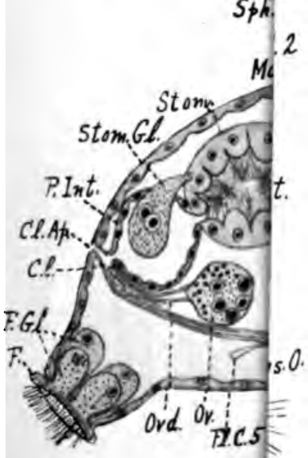
1


2
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P.Int.
Cl.Ap.
Cl.
F.Gl.
F.
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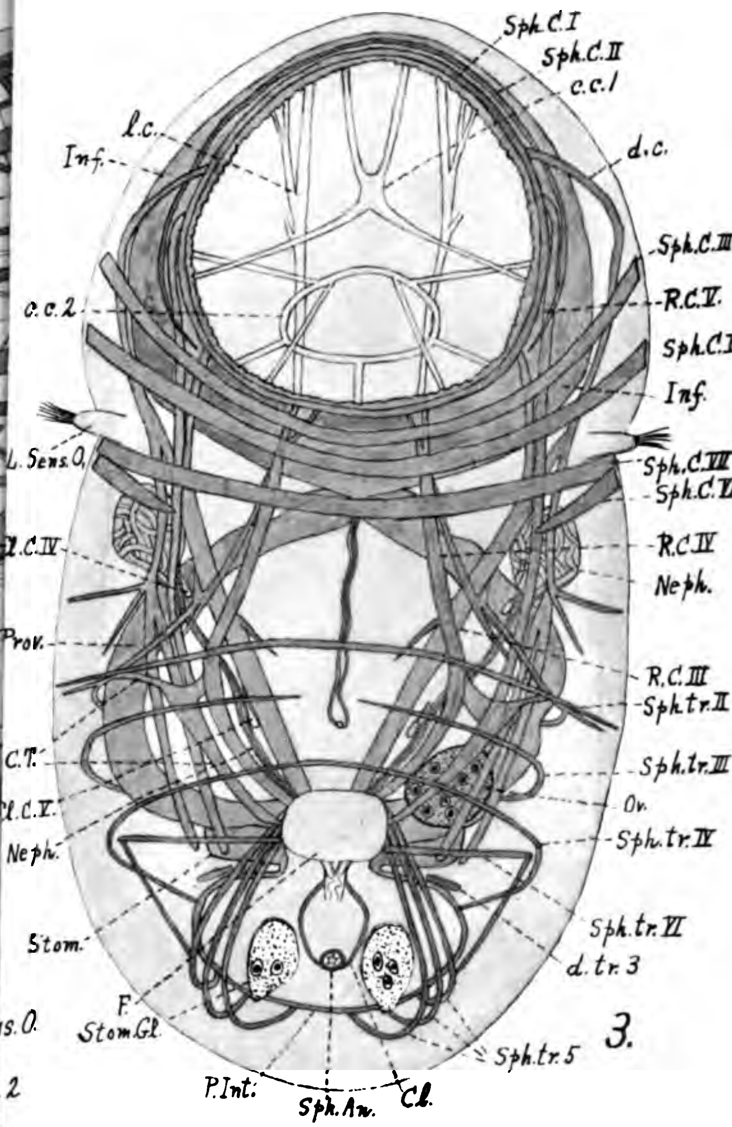
Fl.C.5
s.O.


Sph.C.I
Sph.C.II
c.c.1
l.c.
Inf.
d.c.
Sph.C.III
c.c.2
R.C.V.
Sph.C.VI
Inf.
L. Sens.O.
Sph.C.VII
Sph.C.VIII
l.C.IV
R.C.IV
Neph.
Prov.
R.C.III
Sph.tr.II
C.T.
Sph.tr.III
Ov.
l.C.V.
Neph.
Sph.tr.IV
Stom.
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Stom.Gl.
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P.Int.
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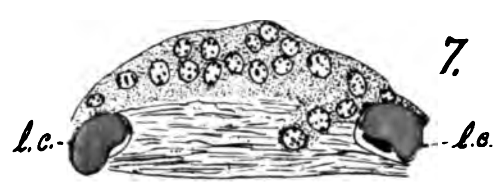
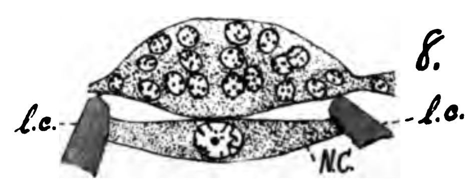
Cl.

3.


l.c.
l.c.

7.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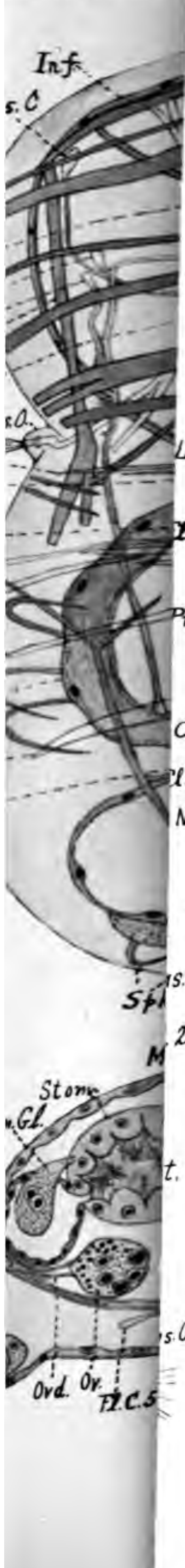
l.c.
NC.

8.


Inf.
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C.T.
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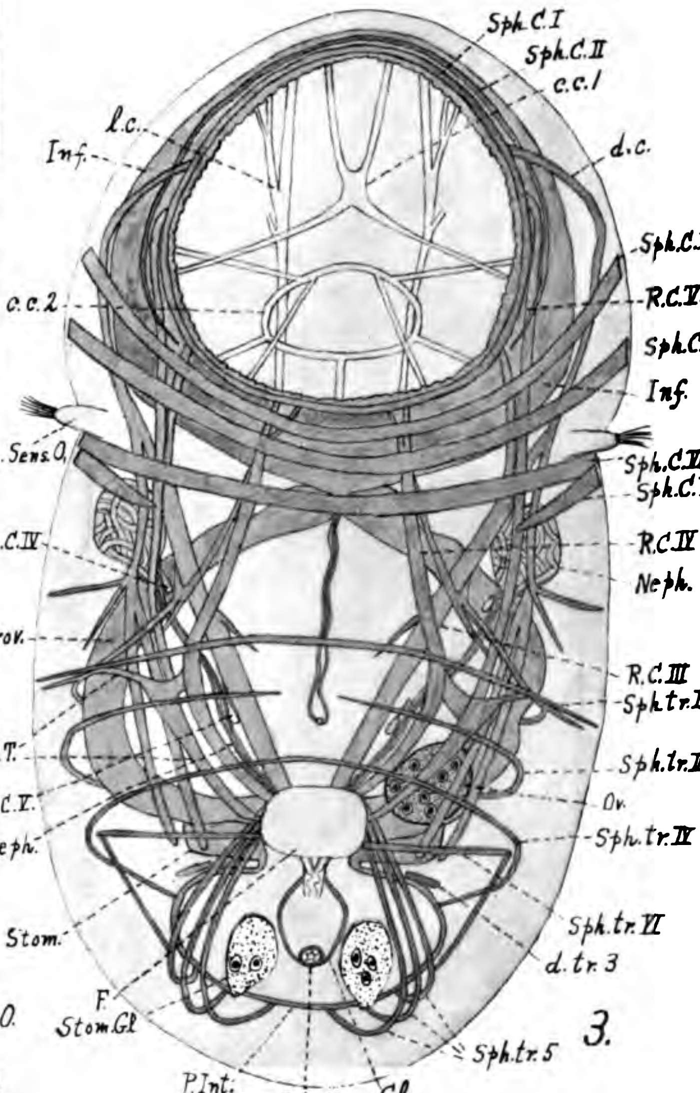
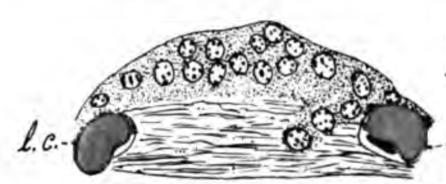
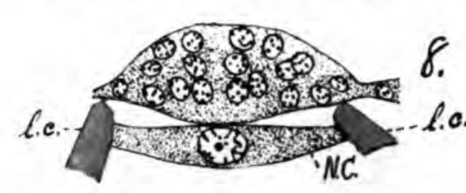
s.O.
Ovd.
Ov.
Fl.C.5


Sph.C.I
Sph.C.II
c.c.1
l.c.
Inf.
d.c.
Sph.C.III
R.C.V.
c.c.2
Sph.C.VI
Inf.
L. Sens.O.
Sph.C.VII
Sph.C.VIII
R.C.IV
Neph.
Prov.
R.C.III
Sph.tr.II
C.T.
Sph.tr.III
l.C.V.
Ov.
Neph.
Sph.tr.IV
Stom.
Sph.tr.VI
d.tr.3
F.
Stom.Gl.
Sph.tr.5
P.Int.
Sph.An.
Cl.

3.


l.c.
l.c.

7.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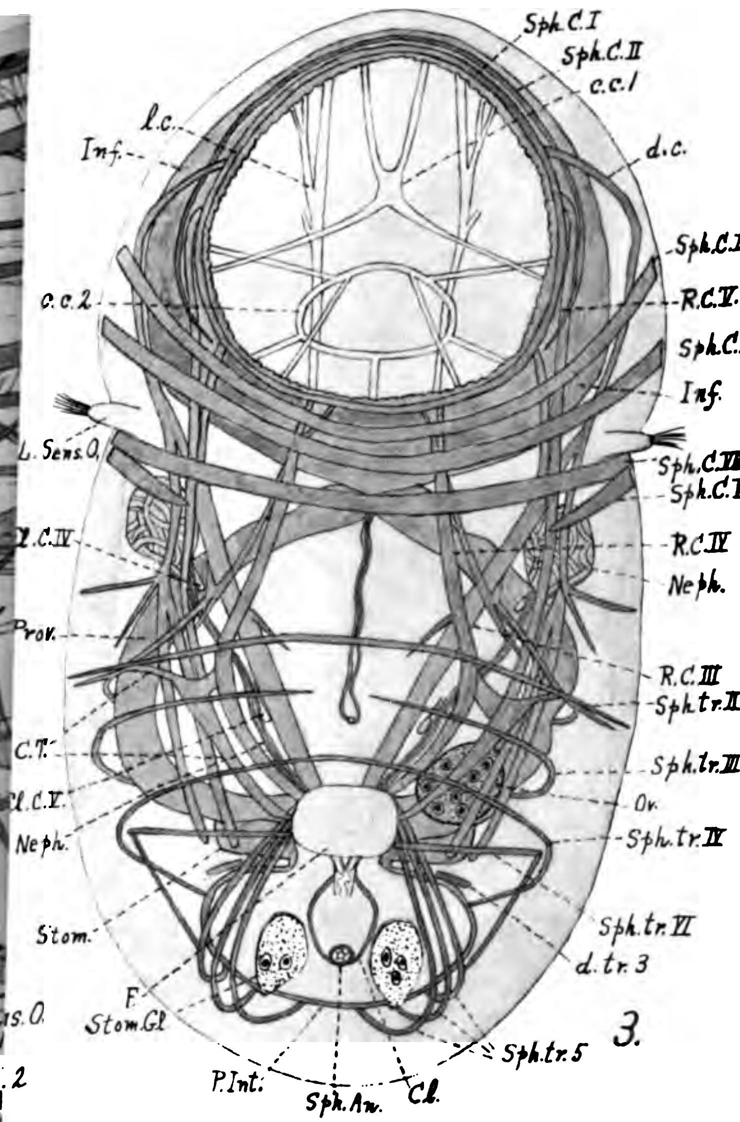
8.

PLATE XVIII.



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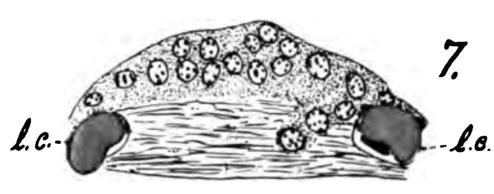

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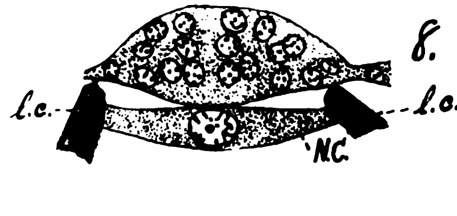

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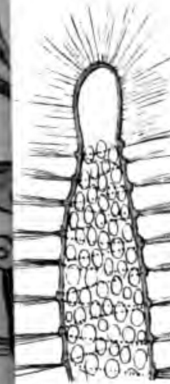
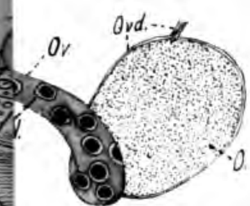


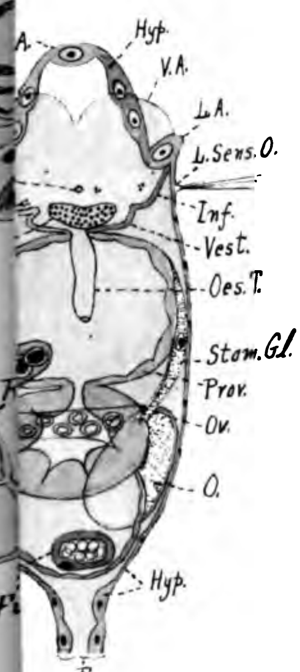
12.

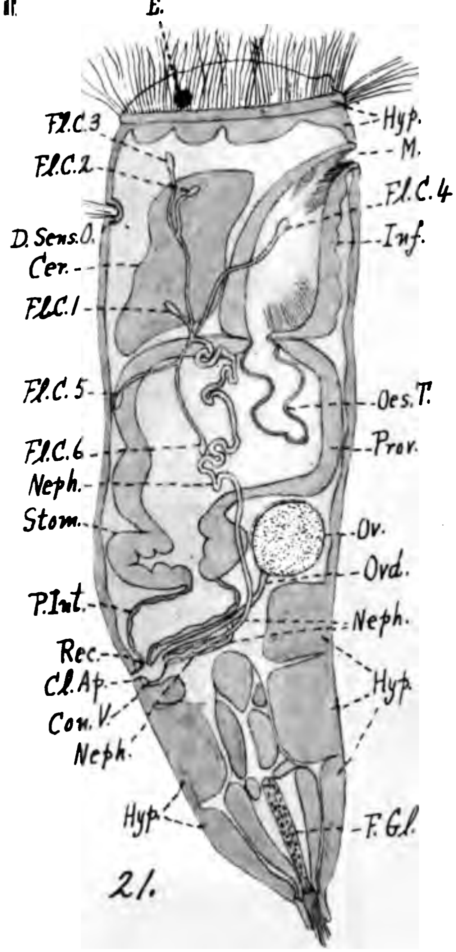
13.

15.

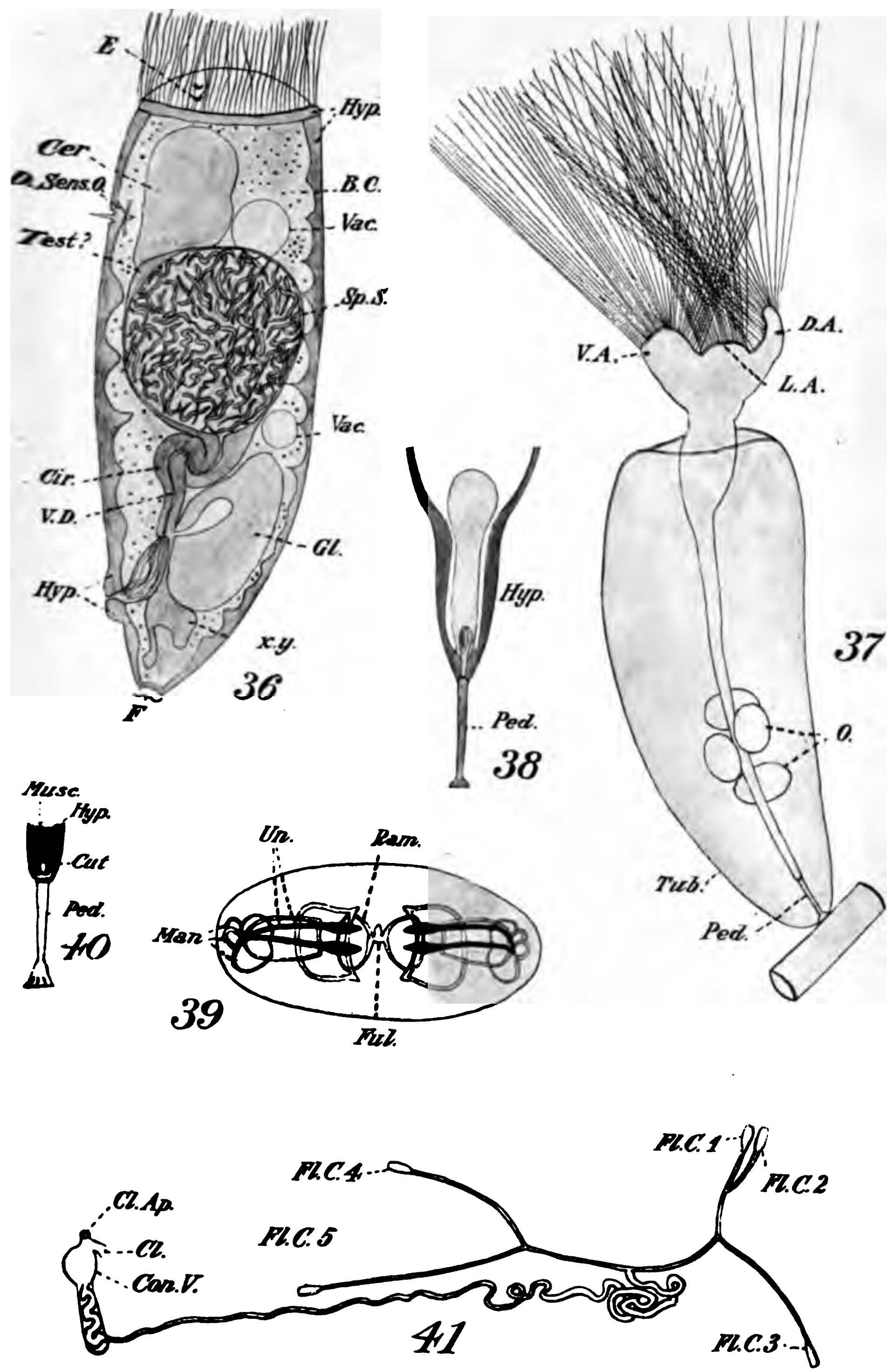
14.





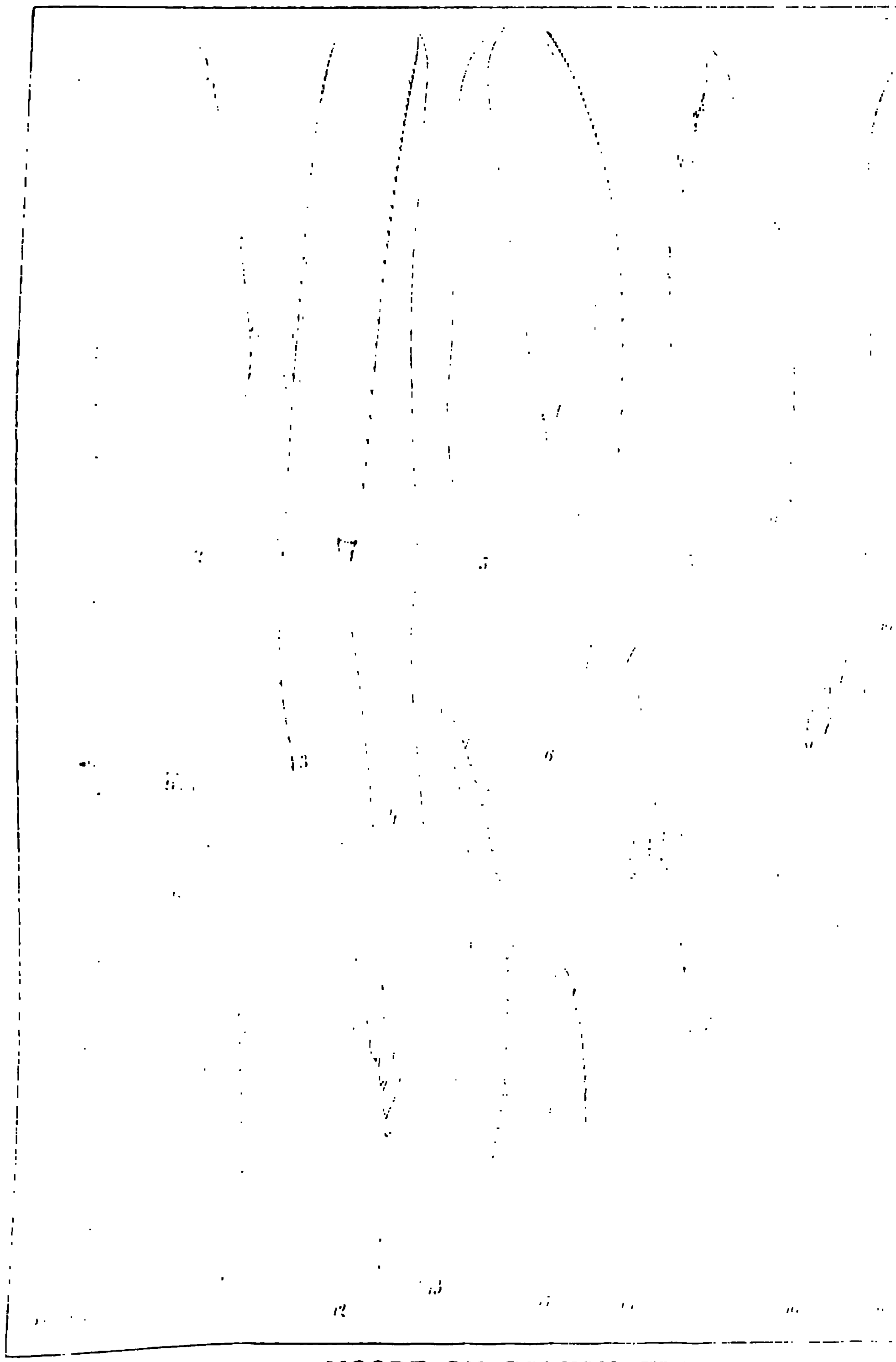


21.

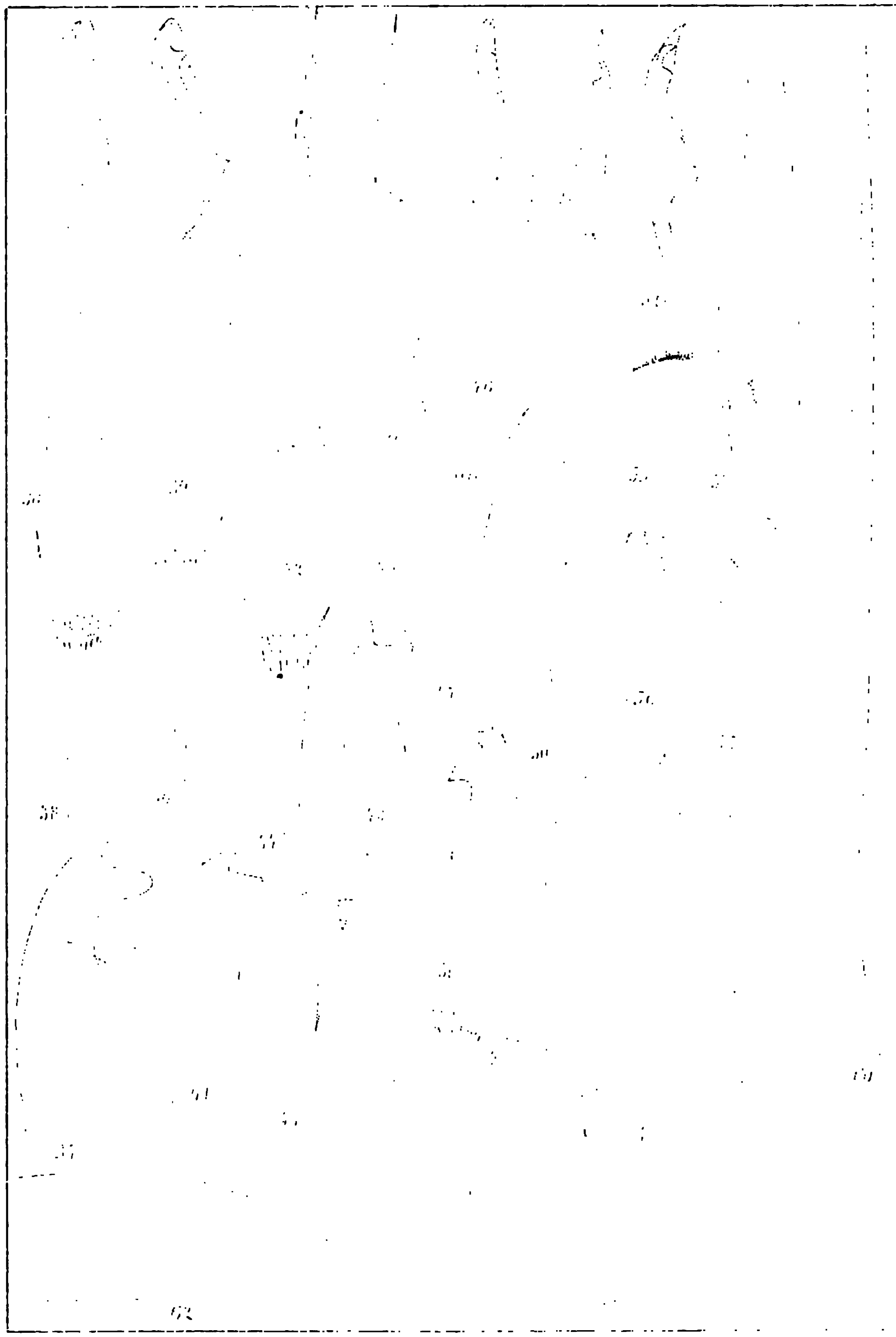


MONTGOMERY. MORPHOLOGY OF FLOSCULARIIDÆ.

PLEUROTOMARIA HIRASEI PILSBRY.



MOORE ON POLYCHAETA.



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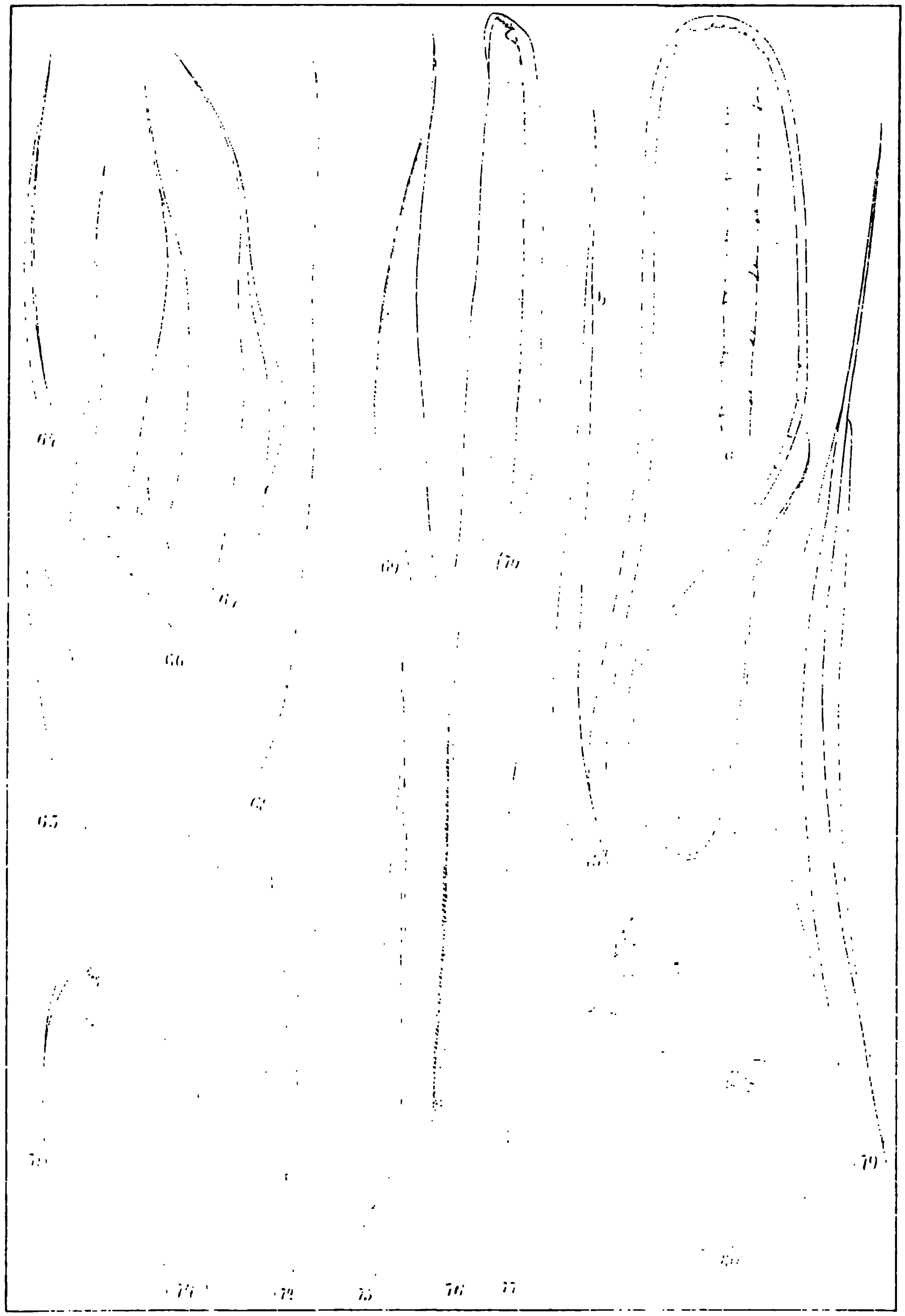

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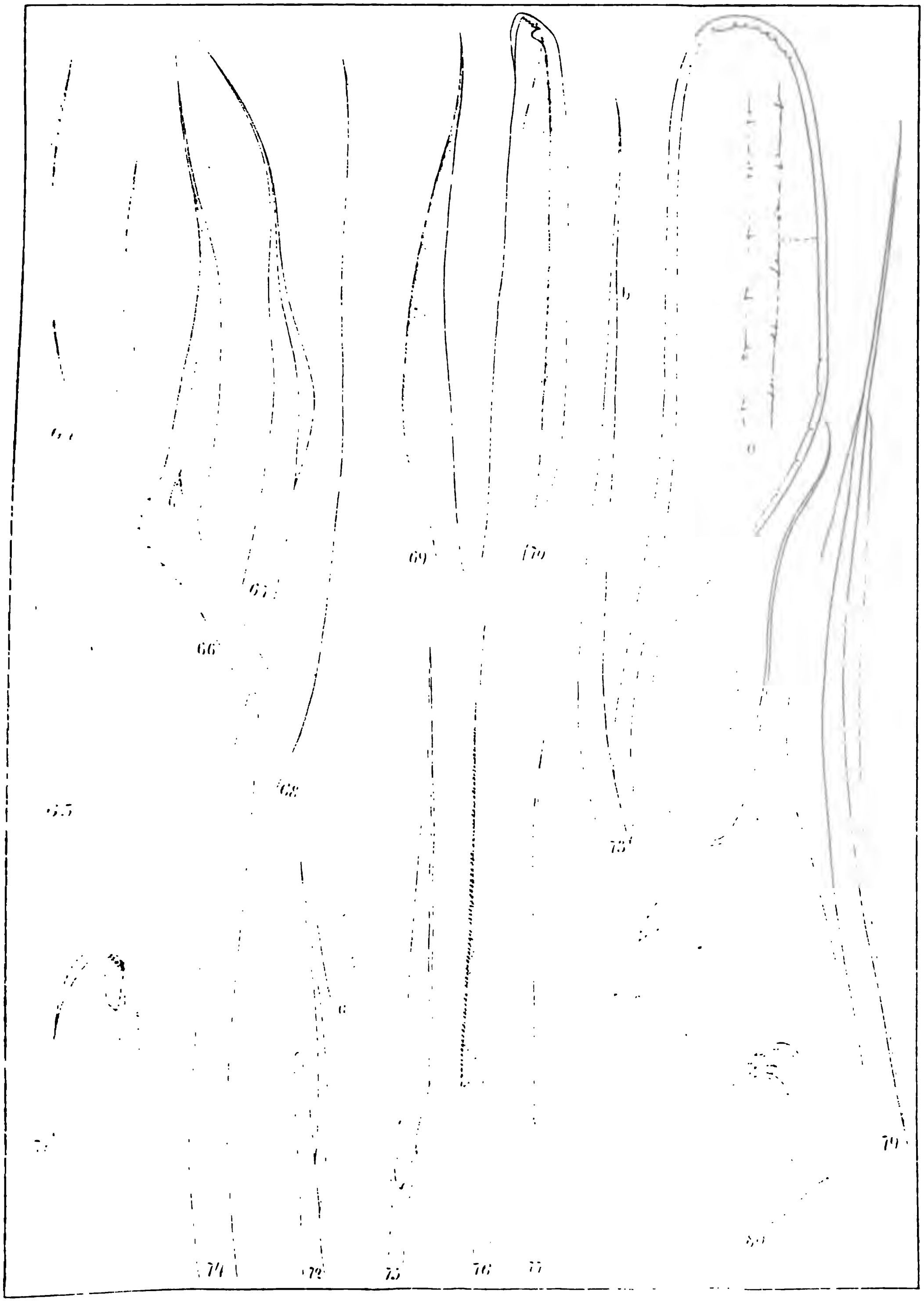
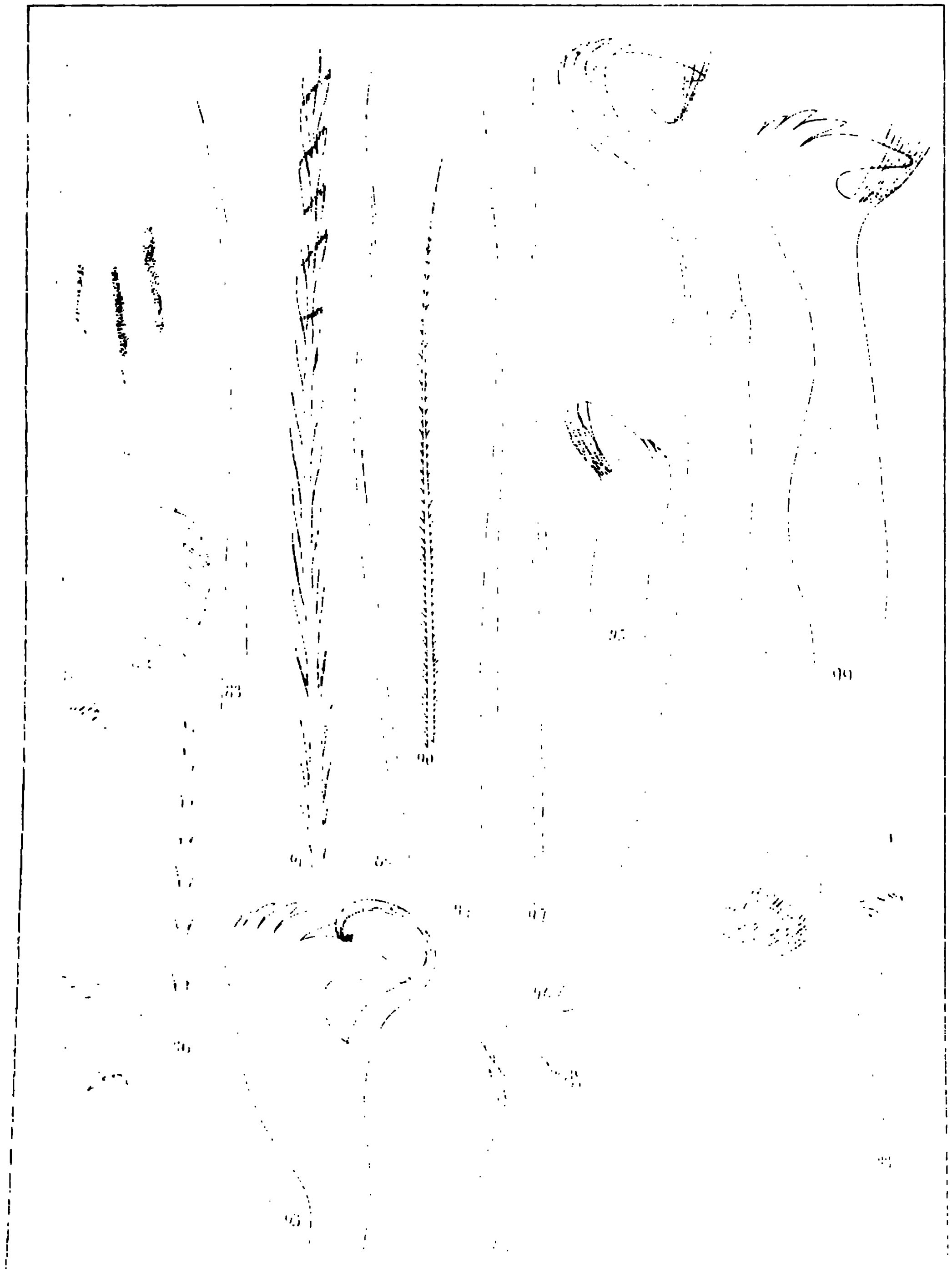


MOORE ON POLYCHAETA



MOORE ON POLYCHAETÆ.

OCTOBER 6.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Twenty-six persons present.

The Curators, Secretaries and Librarian reported on the work of the Academy since the last meeting.

The deaths of Joseph P. Lesley, June 2, and Charles A. Blake, June 24, members; Carl Gegenbauer, June 18, and Augustus R. Grote, September 8, correspondents, were announced.

Note on Crotalus scutulatus Kenn.—MR. A. E. BROWN stated that in a review of the species of North American snakes, published in 1901 by the Academy, he had considered *Crotalus scutulatus* Kenn. to be a synonym of *C. atrox* B. and G. Lately the receipt of a living example from Pecos, Texas, had convinced him that they are distinct. *C. scutulatus* has the scales on the upper surface of the head larger than in most Nearctic rattlesnakes, there being but two scales between the supraorbitals in front, and three behind. Two or three rows below the suborbitals. The rostral is triangular, sharply emarginate and acuminate above. Twenty-three rows of scales. The specimen is curiously intermediate in plan of markings between *C. atrox* and *C. confluentus*. It has the strongly contrasted black tail-bands of the former, while elsewhere the dorsal spots are much like those of *C. confluentus* in shape, in width of separation and in turning to cross-bands on the hinder half of the body. The oblique dark streak below the eye is intermediate both in breadth and direction, and on top of the head the only distinct marking is a black blotch on the prefrontals. the well-defined pattern of *C. confluentus* being absent.

Kennicott and Cope both regarded this species as nearer to *atrox* than appears to be true. It is abundantly distinct and there is no need for a trinomial. *C. atrox* sometimes presents enlarged head scales, but never the dorsal spots turning to cross-bars posteriorly. *C. confluentus*, on the other hand, is wholly different in its markings on head and tail. In its head scales the present species departs from both in the direction of *C. molossus*, from which it is otherwise most unlike.

C. scutulatus is known from northern Mexico, Arizona, and in Texas only from Pecos and, as reported by Mr. Boulenger, from Duval county. It is therefore Sonoran, and does not appear to enter the Austro-riparian.

The following were accepted for publication:

A NEW AMERICAN GENUS OF ARIONIDÆ.

BY HENRY A. PILSBRY.

Among other mollusks received from the Rev. E. H. Ashmun, the fruits of his first season's collecting in Idaho, were a few small slugs, about the size of *Agriolimax campestris* (Binn.). The dark color, carinated tail and tripartite sole led me, upon first glance, to think it an immature *Amalia;* but subsequently, upon opening one to confirm the identification, it became at once obvious that an Arionid slug was before me—a slug not referable to any hitherto known species. This slug shall be called *Zacoleus idahoensis.* It is from Meadows, Washington county, Idaho.[1]

ZACOLEUS, gen. nov.

The genus *Zacoleus* may be briefly defined thus: Ariolimacinæ with the penis a simple sac continued beyond the insertion of the vas deferens; duct of the spermatheca enormously enlarged; marginal teeth with very long zonitoid mesocones, no ectocones; intestine but slightly twisted; sole tripartite; pneumostome behind the posterior third of the mantle; no caudal pore. Central nervous system peculiar by the unusually long cerebral commissure and very short cerebro-visceral and cerebro-pedal connectives.

Zacoleus idahoensis n. sp.

Externally the slug is black on the mantle and back, the flanks and head lighter, slate-colored; the neck or area around the anterior border of the mantle is dirty white. The reticulation is indistinct, and longitudinal lines above, oblique on the sides, predominate, somewhat as in *Prophysaon cœruleum* (Ckll.). Back of the mantle the body is keeled, the tail strongly so. The foot-margin is rather narrow. The sole is narrow, yellowish-white, and divided by longitudinal grooves into three subequal areas. There is no caudal pore, but the acute tail appears somewhat abruptly truncate posteriorly in a view of the profile. The oval mantle somewhat exceeds one-third the length of the body. The pneumostome is situated between the

[1] I am indebted to Mr. E. G. Vanatta for assistance in the examination of these slugs.

posterior third and fourth of its length. One of the largest individuals measures, length 14, breadth of sole 1.3 to 1.5, length of mantle 5.5 mm. In more contracted individuals the sole is somewhat broader in front.

The wholly buried shell is calcareous and moderately strong, oblong, a little convex, the left side more straightened than the right, the slightly projecting blunt apex being terminal. The surface is marked with growth-striæ, and seems to be without periostracum. Length 2.5, width 1.5 mm.

The free retractor muscles are arranged as in *Hesperarion* and its allies, the ocular retractors and the pharyngeal retractor being independent bands converging to the posterior edge of the mantle-cavity where they are inserted in a group (Pl. XXVIII, fig. 6).

The genitalia (Pl. XXVIII, fig. 5) were imperfectly worked out.[2] The penis (*p.*) is a stout, oblong sac receiving the vas deferens a little distad of the middle of its length, and its lumen is there contracted by a fleshy transverse body or sort of valve. Above this the walls are thicker. Both divisions are smooth within. The small spermatheca (*sp.*) is defined by a constriction from the duct (*sp. d.*), which is a very capacious sac, longer than the penis, opening directly into the atrium. Internally this relatively enormous duct has a few coarse longitudinal folds, the number increasing toward the distal end where they are numerous. Its structure, aside from size, is therefore what is ordinarily encountered.

No retractor muscle of the penis was seen, probably owing to the ill preservation of the specimen, or to imperfect attention in the early stage of the dissection. The terminal duct only of the ♀ system could be traced (*ov.*).

The alimentary canal is constructed on the usual Arionid type, though less twisted than in the related genera. The jaw is opaque, very thin, arcuate, and composed of numerous dark plaits or flat ribs separated by thin, transparent, much narrower intervals. In one specimen examined there are over twenty-five narrow ribs (Pl. XXVIII, fig. 3); in another the ribs are much wider and not so numerous (Pl. XXVIII, fig. 2).

The crop is long and capacious, hardly separated from the stomach.

The intestine (Pl. XXVIII, fig. 4) is of the usual four-folded type, the anterior loop caught in the cephalic artery. It is curved in figure

[2] The spirit first used on the specimens was apparently too weak to properly preserve the viscera; and the genitalia and intestine were so soft and tender that their dissection was difficult.

8 fashion, but only slightly twisted. As in other native American *Arionidæ*, the posterior loop formed by the first and second folds of the intestine lies anterior to that formed by the third and fourth folds.

The radula has 31.1.33 teeth in two individuals counted. The median tooth is tricuspid, the lateral teeth bicuspid, both being of the type frequently figured for American *Arionidæ*. There are seven laterals on each side (Pl. XXVIII, fig. 7). The change to the marginals is gradual, and produced by lengthening the main cusp and diminution of the ectocone (Pl. XXVIII, fig. 8). The division of the lateral and marginal fields of the radula (between the seventh and eighth teeth) is obvious in a general view of the ribbon under a low power. The marginal teeth (Pl. XXVIII, figs. 9, 10, 11) have the basal plates shortened, a single long, lance-shaped cusp springing therefrom. These cusps are rather broad on the inner (fig. 9) and the outer (fig. 11) teeth, but long and graceful in the middle of the marginal field (fig. 10).

The central nervous system (Pl. XXVIII, fig. 1) has the commissure between the cerebral ganglia long, even for an Arionid slug. These ganglia are obscurely bilobed. The cerebro-pedal and cerebro-visceral connectives are, on the other hand, excessively short. The subœsophageal group of ganglia exhibits stong concentration, with the exception of the pedal mass.

Affinities of Zacoleus.

The contiguous posterior insertions of the free retractor muscles and the long cusps of the marginal teeth show that this genus belongs to the subfamily *Ariolimacinæ* as defined by Pilsbry and Vanatta.[3] The tripartite sole, peculiar genitalia, total absence of ectocones on the Zonitoid marginal teeth, and the extreme shortening of the side connectives of the circumœsophageal ring, all distinguish this genus from its allies. The tripartite sole it has in common with *Binneya* and *Anadenulus*, both of which differ conspicuously in more important features. Perhaps the tripartite sole was a character of the primitive *Aulacopoda*. It seems to occur somewhat sporadically in some genera of several widely separated families of that group. There is no indication of the auto-urotomy (to coin a word) of *Prophysaon* in our new genus. *Zacoleus* thus stands isolated among known genera. Notwithstanding its strictly aculeate type of marginal teeth, *Zacoleus*

[3] Pilsbry and Vanatta, *Proc. Acad. Nat. Sci. Phila.*, 1898, p. 227; Pilsbry, *Proc. Malac. Soc. London*, III, p. 100.

is evidently a herbivorous slug. The crop and stomach of the specimen dissected were filled with the curiously marked leaves of *Frullania* (Jungermanniaceæ).

Explanation of Plate XXVIII.

Fig. 1.—Central nervous system of *Zacoleus idahoensis*.
Figs. 2, 3.—Jaws.
Fig. 4.—Intestine.
Fig. 5.—Genitalia: *o*, common external orifice; *ov.*, oviduct; *p.*, penis; *sp.* spermatheca; *sp.d.*, duct of the spermatheca.
Fig. 6.—Free retractor muscles.
Figs. 7–11.—Teeth.

A NEW GENUS OF STENOPELMATINÆ (ORTHOPTERA) FROM NEW MEXICO.

BY JAMES A. G. REHN AND T. D. A. COCKERELL.

The material on which this genus is founded was collected in the vicinity of Pecos, San Miguel county, New Mexico, in the summer of 1903, by Mrs. W. P. Cockerell. Two specimens were taken, the larger of which is the type of the genus and species. It appears to be doubtful that it is mature, but that it represents an entirely new type is beyond question. The smaller specimen, taken July 21, is in such condition and of such small size that nothing definite can be determined from it.

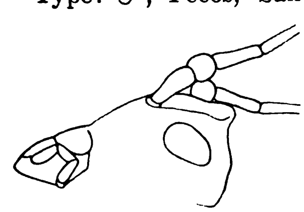
SPILACRIS n. gen.

This genus is a member of the Rhapidophoræ, and belongs either to the Tropidischiæ or represents a group by itself.

Occiput globose; vertex produced into a compressed process; eyes reniform, prominent; antennæ with the basal joint longitudinal, second joint globose, third and succeeding joints longitudinal; palpi simple. Pronotum concave, saddle-shaped, lateral lobes with the lower margin rounded. Wings and tegmina absent.[1] Anal styles acuminate, rather short. Anterior and median femora compressed, the posterior slender, moderately expanded at the base, the apical portion attenuate. Anterior tibiæ imperforate. Tarsi without pulvilli.

Spilacris maculatus n. sp.

Type: ♂; Pecos, San Miguel county, New Mexico, June 24, 1903; on *Fallugia*. (W. P. Cockerell.) [A. N. S. Phila.]



Lateral view of head and basal joints of the antennæ of *Spilacris maculatus* (enlarged).

Size very small; form slender, apterous; surface sparsely haired. Head with the occiput globose; the process of the vertex directed upward, rounded; eyes very prominent; antennæ greatly exceeding the body in length. Pronotum not quite equal to the head in length. Anterior and median femora and tibiæ subequal. Posterior femora almost equal to the body; tibiæ somewhat

[1] As the type is possibly immature, this may be found to be incorrect.

exceeding the length of the femora, without distinct spines, but supplied with regular series of bristles on all the margins. Tarsi with the terminal joint about equal to the others in length; arolia absent.

General color yellow of several tints, maculate on the limbs with blackish. Head orange-yellow above, the vertex with a lateral bar of black; eyes blackish, the postocular region with two parallel longitudinal bars of the same tint; labrum, clypeus and lower portion of the genæ suffused with rose-red; antennæ with the two basal joints blackish, the remainder blackish annulate with yellowish-white. Pronotum orange-yellow with the lateral lobes darker. Abdomen reddish, the terminal appendages black. Anterior femora with two distinct transverse black bars, one apical, the other median, the former is flanked proximally by a bar of clear orange, forming a strong contrast to the yellow basic tint, all overcast by a uniform speckling of small circular black spots, a pattern which entirely covers the tibiæ. Median limbs identical with the anterior pair, except that the orange femoral bar is paler. Posterior femora with the black maculations forming broad annuli basally, spots apically, but wholly suffusing the genicular region; tibiæ spotted, but basally exhibiting a tendency toward annuli.

Measurements.

Length of body,	3.7 mm.
Length of posterior femora,	4 "
Length of posterior tibiæ,	4.5 "

THE POLYCYSTID GREGARINES OF THE UNITED STATES.—Second Contribution.

BY HOWARD CRAWLEY.

I.

The following paper contains the results of my observations on gregarines during the spring and summer of 1903. Two new genera and several new species have been discovered. In addition, some observations on the biology of the animals are described. These concern the cysts and the time required for the maturation of the spores.

II.

ACUTISPORA n. g.

Cysts spherical, with a thick cuticular membrane. Dehiscence by means of an annular pseudocyst, which develops around one end of the ellipsoidal spore-mass, the two together having the form of an acorn. Spore-mass ellipsoidal and enclosed in a tough transparent membrane, which splits into two values by a rupture extending around the major diameter. Maturation period intermediate.

Spores large, navicular in shape and showing epispore and endospore. Ordinarily symmetrical, but sometimes with the longer axis very slightly curved. Endospore a truncated double cone, but with a slightly curved profile, and furnished at either end with a thick, blunt refractive rod, the whole covered over by the epispore. Within a large spherical residuum, either central or lateral, around which the sporozoites are grouped.

The genus contains one species:

Acutispora macrocephala n. sp. Pl. XXX, figs. 1–6

Epimerite: Some of these animals showed an anteriorly directed prolongation of the protomerite which may possibly be regarded as constituting the epimerite. If so, this element is poorly developed and differs considerably in the different individuals. In some cases the entocyte extended into it.

Protomerite: Always showing a deep constriction at the beginning of the posterior third. Large, and relatively larger in the small than in the large animals. Separated from the deutomerite by a sharp constriction.

Deutomerite: Conical, with usually a bluntly rounded posterior end. Broadest just behind the septum and tapering gradually and uniformly.

Epicyte: Thick, showing a double contour all over the animal.

Sarcocyte: Poorly developed or wanting, except for the septum, which dips slightly backward.

Entocyte: Dense in all cases. In the smaller animals, slightly less dense in the protomerite than in the deutomerite.

Nucleus: Invisible.

Dimensions: Length of largest individuals seen, 600 microns.

Cysts: Spherical. Diameter 410 microns, with a cuticular membrane 40 microns thick. No gelatinous envelope. Dimensions of spore-mass 400 by 300 microns. Maturation period 10 days, May 10–20, 1903.

Spores: Length, 19 microns; breadth, 4 microns; refractive rods, 6 microns long.

Host: *Lithobius forficatus* Linn. Found in but one case, and then present in small numbers.

Locality: Raleigh, N. C.

GIGADUCTUS n. g.

Cysts spherical, with a thin gelatinous envelope. Dehiscence by one enormous sporoduct. Maturation period short.

Spores cylindrical, very large. Wall single, thick. Spores marked with diagonal lines, those on one side opposed in direction to those on the other, giving the spore a latticed appearance. These lines are apparently due to the sporozoites, which make up a hollow cylinder lying in contact with the inner surface of the spore wall. The residuum, an ellipsoidal mass liberally provided with granules, occupies the cavity of this hollow cylinder.

The single species is:

Gigaductus parvus n. sp. Pl. XXX, figs. 10–13.

Epimerite: Not seen.

Protomerite: In the primites, generally forming somewhat more than a hemisphere. In the satellites, slightly shortened, with a straight anterior edge. Separated from the deutomerite by a sharp constriction.

Deutomerite: Cylindrical to conical, with a blunt posterior end.

Epicyte: Well developed, showing a double contour. Longitudinally striated.

Sarcocyte: Apparently wanting, except for the septum, which is either plane or dips slightly backward.

Entocyte: Coarsely granular; not dense.

Nucleus: Large, spherical.

Dimensions: Maximum size 150 microns long by 90 microns broad. The satellites are usually slightly smaller than the primites; but sometimes much smaller and sometimes larger. The smallest animal seen was 50 microns long.

Cysts: Diameter 170 microns. Gelatinous envelope 12 microns thick in the young cyst, but becoming very much thicker as maturation proceeds. Cysts remarkably uniform in size. Maturation period 2–3 days, August, 1903.

Spores: Cylindrical, 25 microns long by 10 microns broad. At the ends, the spore wall is raised into a little circular ridge.

Host: Harpalus caliginosus Fab. Infection only occasional, but the gregarines usually present in considerable numbers.

Locality: Wyncote, Pa.

There is a good deal of confusion regarding the gregarines occurring in the Diplopod family Julidæ. These gregarines all bear a certain amount of resemblance to one another, and it has been usual to relegate all of them to the species *Stenophora juli* Frantz. Léger et Duboscq (1903) have recently shown that such a procedure is not warranted for the fauna of Corsica, and the case is certainly the same for that of the eastern United States. The Julidæ of this region are infected with certainly two and possibly three species of *Stenophora,* while the classic *S. juli* apparently does not occur. Of these species, one is unquestionably the form described by Leidy (1853) as *Gregarina julipusulli.* As indicated by the specific name, Leidy considered its host to be *Julus pusillus* Say. According to Bollman (1887) this millipede, correctly *Julus minutus* Brandt, does not occur in Pennsylvania, and it may be that Leidy was mistaken in his identification. This matter is not, however, of any great importance, and the specific name of the gregarine must stand. Leidy spelled the specific name of the host *pusullus,* whereas Say's memoir (1821) renders it *pusillus,* which spelling will be used for the name of the gregarine. The description is as follows:

Stenophora julipusilli (Leidy). Pl. XXX, figs. 16, 17.

Gregarina julipusulli Leidy (1853), p. 238, Pl. 10, figs. 21, 22.
Stenophora juli Crawley (1903), p. 51.

Protomerite: Hemispherical to cylindro-conical to conical. In front a more or less evident papilla, through which there is an apparent pore. Ordinarily broader than long.

Deutomerite: Ordinarily cylindrical to flask-shaped. Occasionally llipsoidal to oval. The cylindrical forms, in which the ratio of readth to length is 1 to 4, display the tendency toward the assumption f the flask shape, in that the greatest breadth is in the posterior half. Vhen the flask shape is assumed, the body of the flask may take up om one-third to three-fourths of the deutomerite. In such cases, ie ratio of breadth to length may be as high as 1 to 2. The contour f the deutomerite is frequently slightly irregular.

Epicyte: Well developed. About 3 microns thick in the deuto- ierite, slightly thinner in the protomerite, except at the anterior tip. [ere it is thickened and shows an apparent pore. There is no evidence iat the epicyte is actually pierced, however, and the apparent pore probably the rudiment of an epimerite. Longitudinal striations onspicuous.

Sarcocyte: Well developed all over the animal. About one-half s thick as the epicyte. Greatly thickened at the anterior tip of the rotomerite. Septum thick, curving backward.

Myocyte: Easily demonstrated by the use of reagents, and visible in ving animals under favorable circumstances.

Entocyte: Uniformly granular. Very dense in the larger animals. iranules of the protomerite differing in character from those of the eutomerite.

Nucleus: Spherical, with one large spherical karyosome.

Hosts: *Julus* and the smaller species of *Parajulus*. What is ap- arently the same gregarine is occasionally present in *Lysiopetalum actarium* Say. Very common.

Locality: Eastern United States.

This species is easily separated from *S. juli* by the size of the pro- omerite. In *S. juli* the length of the protomerite, according to the igures given by Schneider (1875), makes up only about 6 per cent. of he total length. In *S. julipusilli* this proportion increases to 10 per ent. in the adults and 15 per cent. in the young. From *Stenophora arians*, recently described by Léger et Duboscq (1903), *S. julipusilli* liffers in being a larger and bulkier animal and in having the breadth f the protomerite almost invariably greater than the length.

The Diplopod *Parajulus*, while frequently parasitized by *Stenophora ulipusilli*, shows at times other gregarines which cannot be placed n that species. These present themselves under several forms, the lifferences between which, if permanent, are certainly of specific value. My observations, however, have not as yet been thorough

enough to determine how many distinct species there are, and the matter will be reserved for a future communication.

For the following new species, the data at present on hand are not sufficient to warrant formal definitions.

Actinocephalus americanus n. sp. Pl. XXX, fig. 22.

This species is created for a single individual found in *Galerita bicolor* Drury. The beetle is quite common and I have opened perhaps twenty individuals, but only one was parasitized, and then but the one gregarine was present. It is probable that the parasite is only sporadically present in *Galerita*, and that its usual host is some other animal. It is, however, distinct from any of the common species occurring at Wyncote. It is placed in the genus *Actinocephalus* on account of the form of both protomerite and deutomerite, the presence of several karyosomes in the nucleus, and the fact that its host was a carnivorous Arthropod.

The gregarine was 200 microns long, 35 of which represented the length of the protomerite. The two segments were each about 45 microns broad. The epicyte was very distinct and showed a little papilla at the anterior tip of the protomerite. The septum curved forward and the nucleus showed several karyosomes. The entocyte was much denser in the deuteromite than in the protomerite. The animal progressed quite freely in a circle of short radius, but was prevented from taking any lengthy excursions by the surrounding host tissue.

Hoplorhynchus scolopendras n. sp. Pl. XXX, fig. 19.

This species is created for a gregarine parasitic in *Scolopendra woodi* Meinert, from Raleigh, N. C. Two specimens were present. One of these, when first seen, was a balloon-shaped sac, 350 microns long by 200 broad. The epicyte and sarcocyte were each nearly or quite 3 microns thick, and the former was plainly marked with longitudinal striations. Both of the individuals were very flexible, readily changing shape and showing extensive contortions.

After having been upon the slide for perhaps an hour, the parasites became quiescent and assumed what was probably something like the typical shape. The larger then measured 825 microns long by 120 microns broad. The anterior end, as shown in fig. 19, was much narrower than the balance of the animal, but it is somewhat questionable if this narrowing be permanent. A distinct septum extended across this narrower region, cutting off a portion of granular entocyte.

ackward from the broadest portion, the animal's body tapered gradu-lly, ending behind in a point.

This species is placed in the genus *Hoplorhynchus* on account of its lose resemblance to *H. actinotus* Leidy and its occurrence in a centi-ede related to *Scolopocryptops*, the host of the latter.

richorhynchus lithobii n. sp. Pl. XXX, fig. 18.

This animal, which is apparently specifically distinct from any of he other gregarines parasitic in *Lithobius*, was found in a specimen of hat centipede from Raleigh, N. C. An epimerite was not seen. The rotomerite was subcordiform, and displayed in front a differentiation he exact nature of which could not be determined. The deutomerite aried considerably in shape, the animal being quite polymorphic. Both epicyte and sarcocyte were distinct and of about equal thickness. The septum was thick and curved backward. The entocyte was not ense; the nucleus large, with several karyosomes. The largest indi-idual seen was 195 microns long.

Figs. 20 and 21 show a small gregarine frequently encountered in *colopocryptops sexspinosus* Say. Fig. 21 is doubtless that of a very oung specimen which has been loosened from its original attachment y the breaking up of the host intestine upon the slide. The three egments are all marked out. It seems almost certain that this figure epresents a young *Hoplorhynchus actinotus* Leidy. The animal shown n fig. 20 was very like the other in general appearance and had the aleness characteristic of a young animal. There was, however, no pimerite, nor did the individuals seen show any indications of recent nutilations. *H. actinotus* may retain the epimerite until it reaches a ength of 700 microns, whereas the animal here figured was only 45 nicrons long. The observed facts are capable of two interpretations. The one is that *H. actinotus* is to a certain extent dimorphic; that is, the pimerite may be lost very early or it may be retained until the animal as reached nearly or quite the maximum size. The other is that while ig. 21 represents a young individual of *H. actinotus*, fig. 20 is that f a different species. The matter is, however, one best held under dvisement until additional facts are obtained.

There follow certain addenda, mostly with regard to the cysts and pores, to the characters of species previously described.

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Gregarina harpali Crawley (1903), p. 49, Pl. 1, figs. 1–4.

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After having been upon the slide for perhaps an hour, the parasites became quiescent and assumed what was probably something like the typical shape. The larger then measured 825 microns long by 120 microns broad. The anterior end, as shown in fig. 19, was much narrower than the balance of the animal, but it is somewhat questionable if this narrowing be permanent. A distinct septum extended across this narrower region, cutting off a portion of granular entocyte.

enough to determine how many distinct species there are, and the matter will be reserved for a future communication.

For the following new species, the data at present on hand are not sufficient to warrant formal definitions.

Actinocephalus americanus n. sp. Pl. XXX, fig. 22.

This species is created for a single individual found in *Galerita bicolor* Drury. The beetle is quite common and I have opened perhaps twenty individuals, but only one was parasitized, and then but the one gregarine was present. It is probable that the parasite is only sporadically present in *Galerita*, and that its usual host is some other animal. It is, however, distinct from any of the common species occurring at Wyncote. It is placed in the genus *Actinocephalus* on account of the form of both protomerite and deutomerite, the presence of several karyosomes in the nucleus, and the fact that its host was a carnivorous Arthropod.

The gregarine was 200 microns long, 35 of which represented the length of the protomerite. The two segments were each about 45 microns broad. The epicyte was very distinct and showed a little papilla at the anterior tip of the protomerite. The septum curved forward and the nucleus showed several karyosomes. The entocyte was much denser in the deuteromite than in the protomerite. The animal progressed quite freely in a circle of short radius, but was prevented from taking any lengthy excursions by the surrounding host tissue.

Hoplorhynchus scolopendras n. sp. Pl. XXX, fig. 19.

This species is created for a gregarine parasitic in *Scolopendra woodi* Meinert, from Raleigh, N. C. Two specimens were present. One of these, when first seen, was a balloon-shaped sac, 350 microns long by 200 broad. The epicyte and sarcocyte were each nearly or quite 3 microns thick, and the former was plainly marked with longitudinal striations. Both of the individuals were very flexible, readily changing shape and showing extensive contortions.

After having been upon the slide for perhaps an hour, the parasites became quiescent and assumed what was probably something like the typical shape. The larger then measured 825 microns long by 120 microns broad. The anterior end, as shown in fig. 19, was much narrower than the balance of the animal, but it is somewhat questionable if this narrowing be permanent. A distinct septum extended across this narrower region, cutting off a portion of granular entocyte.

3ackward from the broadest portion, the animal's body tapered gradu-lly, ending behind in a point.

This species is placed in the genus *Hoplorhynchus* on account of its lose resemblance to *H. actinotus* Leidy and its occurrence in a centi-ede related to *Scolopocryptops*, the host of the latter.

richorhynchus lithobii n. sp. Pl. XXX, fig. 18.

This animal, which is apparently specifically distinct from any of he other gregarines parasitic in *Lithobius*, was found in a specimen of hat centipede from Raleigh, N. C. An epimerite was not seen. The rotomerite was subcordiform, and displayed in front a differentiation he exact nature of which could not be determined. The deutomerite aried considerably in shape, the animal being quite polymorphic. 3oth epicyte and sarcocyte were distinct and of about equal thickness. 'he septum was thick and curved backward. The entocyte was not ense; the nucleus large, with several karyosomes. The largest indi-idual seen was 195 microns long.

Figs. 20 and 21 show a small gregarine frequently encountered in 3*colopocryptops sexspinosus* Say. Fig. 21 is doubtless that of a very 'oung specimen which has been loosened from its original attachment y the breaking up of the host intestine upon the slide. The three egments are all marked out. It seems almost certain that this figure epresents a young *Hoplorhynchus actinotus* Leidy. The animal shown n fig. 20 was very like the other in general appearance and had the aleness characteristic of a young animal. There was, however, no pimerite, nor did the individuals seen show any indications of recent nutilations. *H. actinotus* may retain the epimerite until it reaches a ength of 700 microns, whereas the animal here figured was only 45 nicrons long. The observed facts are capable of two interpretations. The one is that *H. actinotus* is to a certain extent dimorphic; that is, the pimerite may be lost very early or it may be retained until the animal as reached nearly or quite the maximum size. The other is that while ig. 21 represents a young individual of *H. actinotus*, fig. 20 is that f a different species. The matter is, however, one best held under dvisement until additional facts are obtained.

There follow certain addenda, mostly with regard to the cysts and pores, to the characters of species previously described.

ctinocephalus harpali (Crawley). Pl. XXX, fig. 14.

Gregarina harpali Crawley (1903), p. 49, Pl. 1, figs. 1–4.

To the characters given in my original description of this species dd:

Cysts: When first obtained, 640 microns in diameter, with a cuticular membrane 95 microns thick. The true cyst mass was therefore 450 microns in diameter, and this size was maintained. On the other hand, the cuticular membrane swelled enormously and became ovoid, finally reaching a length of 1150 microns and a breadth of 1000. The cyst opened by simple rupture where this membrane was thinnest. Sporulation was apparently total. Maturation period 9 days, August 14–23, 1903.

Spores: Length 9 microns; breadth 7½ microns. Diamond-shaped in longitudinal and hexagonal in transverse section. Spore wall single, thick, with the cavity entirely filled with hyaline protoplasm containing one or two large to many small granules. The spores were mostly adherent in files or masses, this arrangement being apparently due to a thin pellicle of some gelatinous substance covering the spore wall.

This gregarine reaches a maximum length of 1200 microns. It is very common, being present in considerable numbers in nearly every beetle opened. On the other hand, at least from June to August, the cysts are rare, the above data being obtained from a single specimen.

Gregarina calverti Crawley. Pl. XXX, fig. 15.

Gregarina calverti Crawley (1903), p. 48, Pl. 2, figs. 19–21.

To the original description given of this species add:

Cysts: Spherical, with a cuticular membrane showing concentric striæ. No gelatinous envelope. The young cysts show a second hyaline membrane, 3–4 microns thick, within the striated membrane. Cysts varying in diameter from 250 to 360 microns, the membrane varying in thickness from 20–40 microns. The larger cysts do not necessarily possess the thicker membranes. The cysts are probably in all cases the result of a fusion of two gregarines. Dehiscence effected by sporoducts, from 4–8 in number, not exceeding in length the diameter of the cyst. Sporoducts not always all used in the projection of the spores. Maturation period 4 days, August 18–22, 1903.

Spores: Doliform, 13 microns long by 5 microns broad. A single thick spore wall, which is enclosed within a gelatinous pellicle, serving to hold the spores together in files. Spore contents at first wholly hyaline, but rapidly differentiating into a central spherical residuum and two groups of sporozoites.

Cnemidospora spiroboli (Crawley). Pl. XXX, figs. 7–9.

Stenophora spiroboli Crawley (1903), p. 51, Pl. 2, fig. 22.

To the descriptions originally given of this species add:

Cysts: Spherical, 350–500 microns in diameter, with a cuticular mem—

orane generally about 20 microns thick, but often much thicker. This variation in the thickness of the membrane appears to be due to the quantity of extraneous matter which gets tangled within it as it forms. It was noticeable that the thin walls were clear and clean, while the thick walls were very much matted with substance from the host's intestine. Dehiscence by a slit which, in the cases observed, extended only part way around the cyst. Sporulation partial. Maturation period 8 days, May 17–25, 1903.

Spores: Length $12\frac{1}{2}$ microns; breadth $7\frac{1}{2}$ microns. Two coated, the epispore of some consistent gelatinous substance; the endospore cuticular. The latter presents an elliptical profile, with slightly protruding ends, whereas the epispore is pulled out considerably at the ends, and somewhat irregular in outline. Sporoplasm hyaline, with a central mass of granules. The spores adhere in files and masses.

regarina achetæabbreviatæ Leidy.

Gregarina achetæabbreviatæ Leidy (1853), p. 238, Pl. 11, figs. 33, 34.
Gregarina achetæabbreviatæ Crawley (1903), p. 45, Pl. 3, figs. 34, 35.

To the previous notices of this species add:

Cysts: Spherical, enclosed in a more or less irregularly shaped thick gelatinous envelope. Diameter of the cyst mass, without the gelatinous envelope, 225 microns. Cuticular membrane 6–8 microns thick. The gelatinous envelope varied in thickness from 100–300 microns. Dehiscence by sporoducts, 2–5 in number, reaching a length of 1000 microns. Prior to evagination, the situation of the sporoducts is plainly indicated by the appearance around the periphery of the cyst of dense discoid masses, yellowish in color. This yellowish color is due to the presence of an oil, which, when the sporoducts evert, appears to be within the substance of their walls, and not within their lumina. The two cysts obtained everted their sporoducts one day after removal from the host intestine.

Spores: Unknown, for, rather curiously, although the sporoducts everted, no spores appeared.

The list of the polycystid gregarines of the United States, revised to date, is as follows:

Fam. **GREGARINIDÆ.**

1. Gregarina blattarum Sieb.
2. Gregarina achetæabbreviatæ Leidy.
3. Gregarina passalicornuti Leidy.
4. Gregarina calverti Crawley.
5. Gigaductus parvus Crawley.

6. Hirmocystis ovalis Crawley.
7. Euspora lucani Crawley.
8. Cnemidospora spiroboli Crawley.

Fam. STENOPHORIDÆ.[1]

9. Stenophora julipusilli Leidy.

Fam. DACTYLOPHORIDÆ.

10. Echinomera hispida Aimé Schn.
11. Echinomera microcephala Leidy.
12. Trichorhynchus pulcher Aimé Schn.
13. Trichorhynchus lithobii Crawley.
14. Acutispora macrocephala Crawley.

Fam. ACTINOCEPHALIDÆ.

15. Amphoroides fontariæ Crawley.
16. Asterophora philica Leidy.
17. Asterophora cratoparis Crawley.
18. Stephanophora locustæcarolinæ Leidy.
19. Bothriopsis histrio Aimé Schn.
20. Actinocephalus dujardini Aimé Schn.
21. Actinocephalus harpali Crawley.
22. Actinocephalus americanus Crawley.

Fam. MENOSPORIDÆ.

23. Hoplorhynchus actinotus Leidy.
24. Hoplorhynchus scolopendras Crawley.

Fam. DOLIOCYSTIDÆ.

25. Doliocystis rhyncoboli Crawley.

In addition to the above, there are eight more species. These are all placed in the genus *Gregarina*, but since in no case are either the cysts or spores known, the correctness of this disposition is decidedly in doubt. It is therefore impossible to say to which family they belong. They are as follows:

26. Gregarina termitis Leidy.
27. Gregarina scarabeirelicti Leidy.
28. Gregarina melolonthæbrunneæ Leidy.
29. Gregarina polydesmivirginiensis Leidy.
30. Gregarina elateræ Crawley.

[1] Established by Léger et Duboscq (1903).

31. Gregarina dicæli[2] Crawley.
32. Gregarina xylopini Crawley.
33. Gregarina boletophagi Crawley.

III.

The time required for a gregarine cyst to mature appears to vary to a very remarkable degree. I have information on seven species, as follows:

	No. of days.	Month.
Gregarina achetæabbreviatæ	1	August.
Gigaductus parvus	2–3	August.
Gregarina calverti	4	August.
Cnemidospora spiroboli	8	May.
Actinocephalus harpali	9	August.
Acutispora macrocephala	10	May.
Actinocephalus dujardini	30	April–May.

Although the number of cases is quite small, they point to one or two facts of general interest. The first three species mentioned, in which the period varies from one to four days, are all animals of which the cysts open by means of sporoducts. This suggests the conclusion that when sporoducts are developed the maturation period is shortened, although wherein the signification of this apparent correlation may lie is decidedly problematical.

The most striking case is that of *Gregarina achetæabbreviatæ.* These cysts had not passed to the exterior in the usual way, but were obtained from the intestinal contents of a slaughtered cricket. They then showed the yellowish disks indicative of the approaching eversion of the sporoducts (see p. 639), and in consideration of the short time which elapses from the appearance of these disks to eversion, it is not unlikely that the process may take place in the host intestine. There is no inherent unlikelihood in such an event, although it would probably not lead to auto-infection. The spores, released in the fecal masses of the posterior portion of the cricket gut, would merely pass to the exterior free instead of enclosed within a cyst, there to await their destiny.

In the case of *Gigaductus parvus* the cysts were also removed from the host intestine, which gives this species a very short period. The cysts of *Gregarina calverti* were obtained from the feces of the host, and hence the four days represents the time required after the cyst has

[2] Incorrectly given as *discœli* in the original description.

reached the outside world. In the case of this species, I obtained quite a number of cysts, all of which went through the process in approximately the same time. It is also worthy of note that the spores of these two species mature rapidly. Those of *Gigaductus parvus* showed differentiation into sporozoites as soon as they were ejected from the cysts. *Gregarina calverti* was a trifle slower, but the sporozoites were to be detected within half a day after dehiscence.

Cnemidospora spiroboli, *Actinocephalus harpali* and *Acutispora macrocephala* showed periods of from 8 to 10 days. Of these three species, the cysts of the first two dehisce by simple rupture, that of the third by the formation of a pseudocyst. *A. dujardini*, which was thirty days maturing, also dehisces by simple rupture. Although the facts are few, they point to the conclusion that when dehiscence is by rupture, maturation is a slower process than when sporoducts are formed. Further, the spores of these last-named species did not, for several days, show any differentiation into sporozoites. Of course, temperature is a factor in determining the time, but the cysts of *A. harpali* were exposed to exactly the same conditions as those of the two species of *Gregarina* and of *Gigaductus parvus*.

IV.

The cysts of *Acutispora macrocephala* present some points of interest. They were obtained on May 10, from a specimen of *Lithobius forficatus*, sent me from Raleigh, N. C. At this time they were perfectly spherical, 420 microns in diameter, with a cuticular wall 40 microns thick. There were several cysts in the intestine of the myriapod, all about the same size, and of these two matured. On May 18, the appearance presented is shown in Pl. XXX, fig. 4. The protective membrane was still clear and the cyst proper still very dense. One hemisphere was now considerably larger than the other, and on the surface of this larger hemisphere there were a few indistinct furrows. These furrows do not appear to possess any especial signification, although they may be taken as a sign that the cyst is nearly mature. Two days later, May 20, the cyst presented quite a different aspect. The protective membrane had swollen greatly and was evidently undergoing a rapid decay (fig. 5). At one pole, the upper in the figure, it was much thinner than elsewhere, and it was from this pole that the spores eventually emerged. Within lay the cyst mass, now having the form of an acorn, and consisting of an ellipsoidal body, around one end of which was a thick ring. At the free end of this ellipsoidal body, which is the spore mass, a definitive membrane could be seen. This membrane, although presenting a

curved contour, did not fit closely the internal mass of spores, whence the presence of a liquid may be assumed. The ring-shaped pseudocyst presented the same general appearance as the spore mass, and it also appeared to be inclosed by a membrane. The pseudocyst was so dense that the ellipsoidal body could not be seen through it, but a deep furrow could be detected extending around the line of juncture, giving the entire element the optical section seen in fig. 6. The diameter of the sphere formed by the protective membrane was considerably greater, and now measured 750 microns, as against 420 microns when removed from the centipede.

The next day the cyst had dehisced. It now showed a membranous bag, lying within the disintegrated remains of the pseudocyst. This bag showed two valves, and may be compared with the split shell of a walnut. It was evidently of tough consistence, since movements of the cover-glass, while rumpling it considerably, failed to tear it. It was entirely empty, which fact would seem to indicate that the spores are projected from the cyst with some force when dehiscence takes place.

The mechanics of the process are probably somewhat as follows: The formation of the bulky pseudocyst at one pole causes a gradual weakening of the protective membrane at this pole. In the condition illustrated in fig. 5 the protective coating appears to be reduced to a thin shell enclosing an empty space. This space, however, is doubtless occupied by the substance of the membrane, rendered transparent by the presence of a liberal quantity of water. Eventually the membrane, weakened by the absorption of water, and pressed upon from within by the pseudocyst, yields at the thinnest place and the contained mass is released. Whether the ellipsoidal body splits on account of the opening of the protective membrane, or by means of the liquid which it evidently contains, I do not know. The latter seems to be the more probable reason.

The annular mass has been termed, and I think correctly, a pseudocyst, yet it by no means possesses the permanent nature which this element sometimes displays. It seems probable that we should find various conditions from a mere residual mass to a definitive pseudocyst, since the latter condition is evidently derived from the former. In the case of *Acutispora*, the condition may probably be regarded as intermediate. The pseudocyst has become more than a mere residuum, but has not acquired the definitiveness it reaches in a genus like *Stylorhynchus*.

Cnemidospora spiroboli presents the less evolved condition. In this

case there remained, after dehiscence, a spherical shell, across the surface of which a long rent extended. Within was a considerable quantity of granules, which, upon pressure, escaped from the cyst in two or three large masses. Here we have the primitive condition, a mere residuum, which no doubt takes part in dehiscence by swelling.

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Explanation of Plate XXX.

Fig. 1.—*Acutispora macrocephala* (p. 632). Sporont.
Fig. 2.—*Acutispora macrocephala* (p. 632). Supposed epimerite.
Fig. 3.—*Acutispora macrocephala* (p. 632). Spore.
Figs. 4–6.—*Acutispora macrocephala* (p. 632). Cysts.
Fig. 7.—*Cnemidospora spiroboli* (p. 638). Cyst about to dehisce.
Fig. 8.—*Cnemidospora spiroboli* (p. 638). Empty cyst.
Fig. 9.—*Cnemidospora spiroboli* (p. 638). Spore.
Fig. 10.—*Gigaductus parvus* (p. 633). Association of two sporonts.
Fig. 11.—*Gigaductus parvus* (p. 633). Cyst with everted sporoduct.
Figs. 12, 13.—*Gigaductus parvus* (p. 633). Spores.
Fig. 14.—*Actinocephalus harpali* (p. 637). Spore.
Fig. 15.—*Gregarina calverti* (p. 638). Spore.
Fig. 16.—*Stenophora julipusilli* (p. 634). Outline figure of young animal.
Fig. 17.—*Stenophora julipusilli* (p. 634). Adult.
Fig. 18.—*Trichorhynchus lithobii* (p. 637). Sporont.
Fig. 19.—*Hoplorhynchus scolopendras* (p. 636). Anterior end of relaxed animal.
Fig. 20.—Small gregarine found in *Scolopocryptops* (p. 637).
Fig. 21.—Small gregarine found in *Scolopocryptops*. Supposed to be the young of *H. actinotus* (p. 637).
Fig. 22.—*Actinocephalus americanus* (p. 636). Sporont.

SUPPLEMENTARY NOTES ON SPIDERS OF THE GENERA LYCOSA, PARDOSA, PIRATA AND DOLOMEDES FROM THE NORTHEASTERN UNITED STATES.[1]

BY THOMAS H. MONTGOMERY, JR.

The present is practically a supplement to a former paper by me, entitled "Descriptions of Lycosidæ and Oxyopidæ of Philadelphia and Its Vicinity," published in these *Proceedings* in 1902. I have made further collections of specimens from Philadelphia and West Chester, Pennsylvania, the localities I had studied before, and also collections from Crosswicks, Burlington county, New Jersey, and Wood's Hole, Massachusetts. One new species is described, and descriptions of and notes upon various others are given.

For the comparison of the different species of Lycosidæ the characters of color and dimensions are of little worth, even the ocular arrangements are subject to variation in some forms, so that the best characters are afforded by the structure of the copulatory apparatus in both sexes, by the form and proportion of the cephalothorax, the relative length of the chelicera, and the relative length of the legs to the length of the cephalothorax.

The genera are defined as in my preceding paper; it is my purpose later to revise the genera of this family, for the present characterization of them appears to be artificial, and there must ultimately be a classification upon a different set of characters.

It is noteworthy that the specimens from Wood's Hole average considerably smaller than those of the same species from the other localities, so that there the maritime environment would appear to retard or check growth.

1. Lycosa ocreata pulchra Montg.

Some specimens were secured at Wood's Hole.

2. Lycosa sepulchralis Montg.

The original description of this species was based upon a single ♀ from Philadelphia; since then another ♀ has been secured at West Chester, and also a ♂ from Philadelphia. The ♂ differs from the ♀ in form in that the cephalothorax is relatively much broader across the

[1] Contributions from the Zoological Laboratory of the University of Texas, No. 53.

middle, so that in front it is barely one-half its greatest transverse diameter. The *dimensions* of this ♂ are:

Length of cephalothorax,	4	mm.
Length of abdomen,	3.5	"
Length of first leg,	13.3	"
Length of second leg,	11.5	"
Length of third leg,	10.8	"
Length of fourth leg,	16	"

In *color* the pattern of the cephalothorax and the color of the sternum and inferior surface of the coxæ is as in the ♀; the abdomen has a more distinct dorsal pattern, and the deep black of the venter (containing minute yellow spots) extends further up the sides than in the ♀. But the main color differences in the ♂ are in the legs: the coxæ of all the pairs are black; all the other joints of the three posterior pairs are clear yellow with an indistinct darker annulus on each patella; in the first pair the femora are clear yellow, the patellæ the same color with a dark ring, the tibiæ and proximal portions of the tarsi deep black, the remaining portion of the tarsi and the metatarsi (except a black ring at their distal ends) pale yellow. The palpi have the femora and proximal halves of the tarsus black, the other parts yellow.

This ♂ differs from the ♂ of *Lycosa* (*Tarentula*) *modesta* (Keys.) in its smaller size, differences in the ocular arrangement, and in the coloration of the legs and sternum.

3. Lycosa charonoides Montg.

A male of this species, hitherto known only by the ♀, was secured from the same locality (Philadelphia), and its description follows:

There are differences from the ♀ in the *ocular arrangement;* the eyes of the second row are less than their diameter apart, and the dorsal eye area not more than one-sixth the length of the cephalothorax. The *dimensions* (taken in life) are:

Length of cephalothorax,	4.3	mm.
Length of abdomen,	4.2	"
Length of first leg,	12	"
Length of second leg,	11	"
Length of third leg,	10.5	"
Length of fourth leg,	15	"

Colors in Life.—Cephalothorax marked with black and brown, as follows: a median brown band, as broad anteriorly as the eye area and extending back almost to the edge of the thorax; sides with radiating brown markings, and a marginal and submarginal brown band, both interrupted; all the brown color is due to the presence of hairs, and

the black (most conspicuous as a band on each side of the median one) to their absence. The *sternum* is glistening black, with few hairs. The *abdomen* above blackish with an obscure narrow median brown band, and on each side a row of 6–7 small whitish circular spots, the largest of them most anterior, and the posterior ones transversely connected by lines of brown; the sides are gray, streaked above with blackish; the venter brownish-gray, with rows of small black dots converging from the lung-books to the spinnerets, the region of the genital aperture black, the lung-books yellow, the spinnerets blackish. *Chelicera* and *labrum* black (the latter yellow at its distal end), *maxillæ* reddish-brown. *Legs* reddish-brown; femora of the first pair and femora and tibiæ of the other pairs quite distinctly ringed with black and buff. *Palpi* colored like the first pair of legs, but the tarsal joint black.

The ♂ is thus very similar to the ♀, but differs in the ocular arrangement and in the coloration of the legs.

A good distinction from the allied *L. sepulchralis* Montg., in addition to the differences of the genital organs, is the following: in *charonoides* the dorsal contour of the thorax is straight, and the labium less than half as long as the maxillæ; in *sepulchralis* the dorsal outline of the thorax is arched (the eye area being somewhat depressed), and the labium fully half as long as the maxillæ.

4. Lycosa stonei Montg.

This species is very abundant at Crosswicks, New Jersey.

5. Lycosa verisimilis Montg.

Specimens were secured at Crosswicks, New Jersey.

6. Lycosa arenicola Scudd.

Specimens were secured at Wood's Hole.

7. Lycosa scutulata Hentz.

Specimens from Wood's Hole.

8. Lycosa cinerea (Fabr.).

An adult ♀ from Wood's Hole has a cephalothoracal length of only 5 mm. Numerous specimens from Cold Spring Harbor, Long Island, New York, kindly sent by Miss Annie B. Sargent, are all very lightly colored, with the abdominal markings very indistinct.

9. Lycosa nidicola Emert.

Additional specimens were collected at Crosswicks and Wood's Hole. This is a very variable species in size and color. The *dimensions* of mature ♀♀ in my collection are as follows:

Three specimens from Wood's Hole, cephalothorax 6.5–7.5 mm.
Nine specimens from Crosswicks, cephalothorax 7.8–10.5 mm.
Twelve specimens from West Chester, cephalothorax 8–9 mm.
One specimen from Philadelphia, cephalothorax 8.2 mm.

A large female in the McCook collection (described in my preceding paper) had a cephalothoracal length of 9.2 mm.

The color of the under surface of the abdomen in the females varies from a pale yellowish-brown with a few small scattered black spots to darker with spots much more numerous, and sometimes arranged into three bands converging toward the spinnerets, to blackish. All these variations are found in the same locality. The sternum varies from brown to black, sometimes with a distinct light median band or anterior half (all specimens from Wood's Hole and one from West Chester), or without such a band. In the largest female from Crosswicks the annulations on the legs and the converging dark bands on the venter are as distinct as in *L. inhonesta* (Keys.).

The males also differ considerably in size, as shown by two recently acquired mature specimens from Philadelphia:

Length of cephalothorax, ...	4.3 mm.–	6.6 mm.		
Length of abdomen, ...	4	"	– 5	"
Length of first leg, ...	16 .	"	–24	"
Length of second leg, ...	16.2	"	–22	"
Length of third leg, ...	15.5	"	–20	"
Length of fourth leg, ...	21	"	–27	"

The color in life of these two males is as follows: *Cephalothorax* blackish, a narrow buff-brown median line extending from the forehead to the end of the thorax, barely as wide as the space between the eyes of the second row, in one specimen to each side of the anterior end of this stripe a narrower parallel stripe; an interrupted broader, marginal band of the same color, and composed of long hairs. *Sternum* pale greenish, covered with long hairs. *Abdomen* above anteriorly with a blackish median mark largest just before its termination at the middle of the dorsum, bordered by buff-brown broad stripes, and each of the latter by a blackish stripe which extends to the spinnerets; posterior portion of the dorsum blackish, with indistinct buff-brown spots, in one specimen with a pair of white spots; sides pale yellowish; venter pale yellowish, in one specimen with black spots. *Legs* pale yellowish-brown, metatarsus of the first pair blackish, distal end of the tarsi of the other pairs blackish. *Palpi* colored like legs, but the tarsi blackish on the inferior aspect. *Chelicera* yellowish-brown,

covered anteriorly with whitish hairs. *Labium* and *maxillæ* pale yellowish-brown.

This species differs from *L. inhonesta* (Keys.) in the greater relative length of the dorsal eye area, and in the smaller relative length of the chelicera.

10. Lycosa lepida (Keys.).

Numerous additional specimens from Wood's Hole and Crosswicks. Those from Wood's Hole are much smaller than from the other localities; in the males the cephalothorax varies from 3.2–4 mm., and in the females from 3.5–5 mm.

11. Lycosa frondicola Emert.

A specimen from Wood's Hole.

12. Lycosa purcelli Montg.

Specimens from Crosswicks.

13. Lycosa contestata, n. sp.

One mature ♀ (type), bearing a cocoon, from Wood's Hole, and three immature specimens of probably this species from the same locality.

Eyes.—First row almost as broad as the second (the middle points of its lateral eyes more lateral than the middle points of the eyes of the second row), its middle eyes larger and slightly higher. Eyes of the second row largest, more than their diameter apart. Eyes of the third row much nearer to the second row than to each other. Dorsal eye area more than one-fifth the length of the cephalothorax.

Form.—Cephalothorax highest just back of the posterior eyes, in front slightly broader than one-half its greatest transverse diameter. Head sloping and rounded on the sides. The length of the chelicera is about twice the height of the head in front. Sternum longer than broad. Labium almost one-half the length of the maxillæ. Legs stout. Epigynum very small. As seen from above the anterior edge of the cephalothorax appears quite straight.

Dimensions.

Length of cephalothorax,	5.2 mm.
Length of abdomen,	5 "
Length of first leg,	15 "
Length of second leg,	14.2 "
Length of third leg,	.13 "
Length of fourth leg,	.19 "

Color in alcohol.—*Cephalothorax* above with a black stripe joining and surrounding the eyes of the second and third rows of each side, the sides of the head and forehead buff; a buff median band as broad as

the eye area extends from the eyes to about the middle of the thorax, where it is laterally indented, and from the region of the dorsal groove backward becomes gradually narrower; on each side is a narrower, submarginal buff-brown; the rest of the thorax is darker brown, with radiating lines from the dorsal groove. *Sternum* buff, a little darker than the coxæ. *Abdomen* above much darker than the cephalothorax, mainly chocolate-brown with black markings; at each antero-lateral margin a black patch, a pair of white dots connected by a transverse black line on the anterior dorsum, several pairs of black spots (the most posterior of them connected by transverse black lines) on the posterior dorsum as well as 2 or 3 pairs of white spots, and irregular black streaks on the sides; the venter is yellowish in the epigynal region, behind this light brown with a narrow dark brown from the epigynum almost to the spinnerets and with numerous small black spots. *Chelicera* reddish-brown with long black hairs; *labium* and *maxillæ* like the sternum. *Legs* pale buff, lighter beneath, with darker annulations on the superior surfaces of all the joints. *Spinnerets* chocolate-brown.

Comparisons.—This form approaches most closely *L. pratensis* Emerton, but differs notably in the structure of the epigynum, and also in the coloration of the abdomen.

14. Lycosa (Trochosa) avara (Keys.).

One mature ♀ from Philadelphia.

Eyes.—First row almost straight, narrower than the second row (the middle points of its lateral eyes are more lateral than the middle points of the eyes of the second row), nearer to the second row than to the margin of the forehead, its middle eyes slightly larger and a little higher than its lateral eyes. Eyes of the second row largest, not quite their diameters apart. Third row widest, its eyes nearer to the second row than to each other. Dorsal eye area about one-sixth the length of the cephalothorax.

Form.—Cephalothorax highest at the dorsal groove, in front fully one-half its greatest transverse diameter; head rather low and its sides moderately sloping. Sternum longer than broad. Labium less than one-half the length of the maxillæ. Chelicera strong, their length fully double the height of the head in front. Legs stout.

Dimensions.

Length of cephalothorax,	5	mm.
Length of abdomen,	6	"
Length of first leg,	12	"
Length of second leg,	10.5	"

Dimensions.

Length of third leg	10.5 mm.
Length of fourth leg, ...	15.5 "

Color in alcohol.—*Cephalothorax* above with a clear reddish-yellow median band extending from the second eye row to the posterior edge of the thorax; this band is broadest close behind the posterior eyes, there fully as broad as the eye area and enclosing on each side an elongate darker mark and a dark line between the posterior eyes, it is notched at the middle of the thorax and becomes narrower behind this point; a narrow line of the same color borders the eye area laterally and anteriorly; to each side of the median band the thorax is darker brown with a rather indistinct submarginal, yellowish band, and with blackish stripes radiating from the dorsal groove. *Sternum* pale yellowish-brown, like the inferior surfaces of the coxæ. *Abdomen* above dull brownish obscurely mottled with yellowish, the brown forming an indistinct median and a pair of lateral bands on the anterior half; sides and venter clear yellowish-brown, with small brown spots most numerous near the spinnerets; the latter deep reddish-brown. *Chelicera* deep rufous-red, *maxillæ* a little paler, *labium* nearly black with a lighter tip. *Legs* reddish-yellow, about the color of the median cephalothoracal band, ringed with darker brown on the femora and patellæ, more distinctly above than below, and with more obscure annulation on the tibiæ. *Palpi* colored like the legs.

Comparisons.—This specimen agrees very closely with Keyserling's description. It has certain resemblances to *L. nigraurata* Montg. (of which only the ♂ is known), but is smaller and with a different coloration, particularly of the thorax and the venter. It also resembles *L. rufiventris* Banks, especially in the form of the epigynum, but *rufiventris* is slightly larger and has the "abdomen above and below red-brown like the sternum."

15. Lycosa pratensis Emert.

Two females from Wood's Hole.

Eyes.—First row as wide as the second, its middle eyes larger than its lateral. Eyes of second row largest, their diameter apart. Eyes of the third row nearer to the second row than to each other. Dorsal eye area about one-sixth the length of the cephalothorax.

Form.—Cephalothorax highest just in front of the dorsal groove, in front more than one-half its greatest transverse diameter. Length of the chelicera about one and a half times the height of the head in front. Sternum longer than broad. Legs stout.

Dimensions.

Length of cephalothorax,	4.4 mm.
Length of abdomen,	4 "
Length of first leg,	10 "
Length of second leg,	9 "
Length of third leg,	8.8 "
Length of fourth leg,	12 "

Color in alcohol.—*Cephalothorax* above reddish-brown, a broad, median yellow band surrounds the eye area and extends backward (enclosing a pair of brown lines) to just in front of the median groove where it is constricted, and narrows from this point back to the margin of the cephalothorax; on each side an interrupted, submarginal yellow band. *Sternum* reddish-brown, a little darker than the coxæ. *Abdomen* above dark olive-brown, on its anterior half a light median band edged by black lines and ending in a point at the middle of the dorsum, and on each side along the whole length of the abdomen a row of yellowish dots; venter reddish-brown, sides and region just in front of spinnerets dark olive-brown. *Chelicera* dark chestnut-brown, *labium* the same, *maxillæ* like the sternum. *Legs* yellowish, indistinctly ringed on femora, patellæ and tibiæ with brown, tarsi and metatarsi darker.

16. Pardosa nigropalpis Emert.

Additional specimens from Crosswicks and Wood's Hole.

17. Pardosa scita Montg.

Specimens from West Chester.

18. Pardosa lapidicina Emert.

Specimens from Wood's Hole.

Eyes.—First row shorter than the second, almost straight, its eyes subequal. Eyes of second row largest, about twice their diameter apart. Third row widest, its eyes nearer to the second row than to each other. Dorsal eye area one-quarter the length of the cephalothorax; in the ♂ this area has a shorter proportionate length.

Form.—*Cephalothorax* relatively broad and flat, highest in the eye region, in front about one-half its greatest transverse diameter. Length of the chelicera about one and a half times the height of the head in front. Sternum longer than broad. Legs long and slender. Posterior spinnerets decidedly longer than the anterior.

Dimensions.

	♂	♀
Length of cephalothorax,	3.4 mm.	3.5 mm.
Length of abdomen,	3.5 "	6 "

Dimensions.	♂	♀
Length of first leg,	12 mm.	12.5 mm.
Length of second leg,	12 "	12 "
Length of third leg,	12 "	12.5 "
Length of fourth leg,	15.5 "	17.5 "

Color in alcohol, ♀♀.—*Cephalothorax* above blackish, black in eye region; an indistinct, irregularly bounded, broad median lighter area, and irregular markings of the same color composing an indistinct submarginal band. *Sternum* black. *Abdomen* above deep olive-gray, on the anterior half with a more or less distinct narrow median band of yellowish bordered on each side by a black line, and on the posterior half either a row of transverse yellowish bands each enclosing a pair of black spots, or else on each side a row of yellowish spots; sides finely mottled with olive-gray and yellowish; venter yellowish-brown, bordered laterally and just anterior to spinnerets by dark olive-gray. *Chelicera* clear reddish-brown, *maxillæ* olive-brown, *labium* black proximally and yellow distally. *Legs* annulated above with blackish and yellowish on all the joints except the metatarsi, and with a longitudinal yellowish stripe on the posterior aspect of each femur; on their lower surfaces the coxæ and femora are greenish or olive-gray, each coxa with a proximal light spot, the other joints more yellowish.

Color in alcohol, ♂.—Like the ♀, but with the superior surfaces of the thorax and abdomen nearly black and their color patterns barely distinguishable.

19. Pardosa pallida Emert.

One ♀ from Wood's Hole.

Eyes.—First row much shorter than the second, straight, its eyes equal in size. Eyes of the second row largest, fully one and a half times their diameter apart. Eyes of the third row nearly as far from the second row as from each other.

Form.—Cephalothorax highest at the posterior eyes, in front less than one-half its greatest transverse diameter. Length of the chelicera less than the height of the head in front. Sternum longer than broad. Labium less than one-half the length of the maxillæ. Legs long and slender. Posterior spinnerets double the length of the anterior.

Dimensions.	
Length of cephalothorax,	2.8 mm.
Length of abdomen,	2.5 "
Length of first leg,	8.2 "
Length of second leg,	7.8 "
Length of third leg,	8 "
Length of fourth leg,	12.3 "

Color in alcohol.—*Cephalothorax* above yellow, a broad brown stripe from each posterior eye backward to the end of the thorax, a narrow blackish line on each side near the margin, extreme margin black; black around the posterior eyes and between the middle eyes, forehead yellow, long white hairs above the first eye row. *Sternum* pale yellow about the color of the coxæ, with black spots on the lateral margins. *Abdomen* above with a pale orange, broad median band extending its entire length, in the anterior half of this band a somewhat darker band bordered on each side by small black spots; sides grayish with short black streaks; venter with a black line from each lung-book to the spinnerets, the space enclosed by these lines silvery-gray. *Spinnerets* yellowish. *Chelicera* and *maxillæ* of the same yellowish color as the cephalothorax, *labium* blackish. All the *legs* greenish-yellow below, the two posterior pairs darker; coxæ and trochanters above each with 2 or 3 black spots, and femora above each with a short black stripe on the proximal portion. *Pedipalpi* yellowish, unspotted.

20. Pirata humicolus Montg.

Numerous specimens from Crosswicks.

21. Pirata liber Montg.

Specimens from West Chester, Crosswicks and Wood's Hole. Those from Wood's Hole compose a geographical race characterized by smaller size (largest ♀ with a cephalothoracal length of only 2.6 mm.), and by the proportionately greater extent of the dorsal eye area, which is somewhat less than one-quarter the length of the cephalothorax.

22. Dolomedes urinator Hentz.

Specimens from Crosswicks.

23. Dolomedes idoneus Montg.

Specimens from Crosswicks.

24. Dolomedes sexpunctatus Hentz.

One mature ♀ from Wood's Hole.

Eyes.—The first row about the diameter of its eyes from the second and fully four times their diameter from the anterior edge of the head, broader than the second row, its lateral eyes slightly higher than the middle. Eyes of the second row barely their diameter apart, slightly smaller than those of the third row. Third row broadest, its eyes on eminences, this row about the diameter of one of its eyes behind the second row. Dorsal eye area less than one-fifth the length of the cephalothorax.

Form.—Cephalothorax distinctly longer than broad, highest behind its middle. Length of the chelicera about one and a third times the

height of the head in front. Sternum as broad as long, heart-shaped. Legs stout. Labium less than one-half the length of the maxillæ.

Dimensions.

Length of cephalothorax,	6.5 mm.
Length of abdomen,	6.5 "
Length of first leg,	21.2 "
Length of second leg,	21.2 "
Length of third leg,	20 "
Length of fourth leg,	25 "

Color in alcohol.—*Cephalothorax* above greenish-brown, on each side a bright white band extending from the cheek to the posterior end of the thorax; a thin, interrupted black marginal line; a very narrow pale yellow median band from the plane of the posterior eyes backward, and just behind each posterior eye a short line of the same color; near the middle of the dorsum, touching the median band, a pair of small brown spots. *Sternum* yellow, on each side three distinct black spots. *Abdomen* above a chocolate-brown, on its anterior third a lighter band; five pairs of black spots, which successively decrease in size backward, on the dorsum, the centre of each of which is a minute white spot; on the sides a broad band of gray hairs; sides of venter brown, the area between the lung-books and the spinnerets yellowish. *Legs* yellowish-green above, tarsi and metatarsi darker; below the femora pale sea-green, and the coxæ pale yellow like the sternum; no dark annulations. *Chelicera* reddish-brown, *labium* and *maxillæ* dark chocolate-brown.

Explanation of Plate.

All the figures represent camera drawings of the copulatory apparatus.

Fig. 1.—*Lycosa sepulchralis*, ♂ pedipalp.
Fig. 2.—*Lycosa avara*, epigynum.
Fig. 3.—*Pardosa pallida*, epigynum.
Fig. 4.—*Lycosa contestata*, epigynum.
Fig. 5.—*Dolomedes sexpunctatus*, epigynum.
Fig. 6.—*Pardosa lapidicina*, epigynum.
Fig. 7.—*Lycosa charonoides*, ♂ pedipalp.
Fig. 8.—*Lycosa pratensis*, epigynum.
Fig. 9.—*Pardosa lapidicina*, ♂ pedipalp.

RACIAL VARIATION IN PLANTS AND ANIMALS, WITH SPECIAL REFERENCE TO THE VIOLETS OF PHILADELPHIA AND VICINITY.

BY WITMER STONE.

Having for a number of years been interested in racial variation among terrestrial vertebrates and its relation to environment and climatic conditions, I was recently led to make some investigations along the same lines among our phænerogamic plants, in some genera of which, notably *Cratægus*, *Panicum*, *Viola*, etc., species and subspecies have of late years been described at a rate quite equal to that which has prevailed for some time past among the birds and mammals.

The genus *Viola* was selected for study because I have long been familiar with the more common species found in the vicinity of Philadelphia, and because an abundance of material is easily accessible in this neighborhood.

While my studies have thrown little light upon the relation of variations to conditions of environment, they have enabled me to present a pretty complete account of the variations exhibited by our local violets which may prove of assistance to those who investigate this interesting genus.

Any one at all in touch with the progress of systematic zoology and botany must be aware of the enormous number of new species and subspecies that have been named and described during the last decade. By some, especially those who have not gone very deeply into systematic work, this tendency has been severely criticised as unwarranted multiplication of names in the interest of the describer, which tends to render specific identification more difficult on the part of the general student. To those who have given the matter serious consideration, however, it must be evident that slowly but surely our conception of a species has been changing, and that the recognition of a very large number of new forms in systematic work is an obvious necessity on evolutionary and philogenetic grounds.

The enormous collections that have been gathered together in recent years, especially in the United States, covering thoroughly, as they do, large contiguous areas instead of isolated spots as heretofore, show us that instead of sharply defined widespread species we have, in

nany cases, a number of slightly differentiated local forms, sometimes usceptible of being banded together as races of one specific group or ometimes so intricately interrelated as to involve several previously vell-established "species," and to render any arrangement in groups a natter of the closest study and more or less arbitrary decision.

No one description will accurately cover all of these related races, nd as the specific descriptions of older writers are often based entirely ipon one race or form, there is obviously no course but to recognize he others on an equal basis.

Whether or not our present system of nomenclature will prove nadequate for the purpose remains to be seen, but under any circumstances the recognition of these forms which nature has differentiated n a greater or lesser degree will be inevitable, as it is becoming obvious hat they, instead of the clumsy specific aggregate, are the fundanental units of systematic work.

The existence of these "variants" among vertebrates was first learly accepted in the *Check List of North American Birds*, issued by he American Ornithologists' Union in 1886, and a system of trinomials was adopted by which they could be independently designated and at the same time their relation to their specific aggregate denoted. This plan has been largely followed in vertebrate zoology since this time, but as material and knowledge has increased the difficulty of grouping forms in specific aggregates, in such a manner as not to do violence to the proper function of a name on the one hand and to a fact of evolution on the other, has so increased that by some writers trinomials have been all but abandoned, and binomials employed to designate every form, no matter how slightly differentiated. In botany, where the trinomial system has never been so widely adopted as in vertebrates, almost all the recently named forms are designated as species.

As I have elsewhere stated,[1] I am convinced that the use of trinomials is still our best method for denoting these races, though not on exactly the basis originally proposed in the American Ornithologists' Union Code of Nomenclature.

The results of my study of variation in the genus *Viola* I have onsidered under three headings: Racial Variation, as exhibited in lants; Variation in the Genus Viola; and a Synopsis of the Violets of Philadelphia and vicinity. For the sake of comparison I have preeded these with a brief *résumé* of racial variation among terrestrial ertebrates.

[1] Condor, 1903, p. 43.

Racial Variation among Terrestrial Vertebrates.

Variation in animals may be of several different types: (1) sexual, (2) age and seasonal, (3) dimorphic, (4) individual, albinistic, etc., and (5) specific or racial.

We have a terse nomenclature by which differences of sex, age, etc., may be denoted, and sometimes, as in birds, quite a complicated terminology by which every plumage is designated (cf. Dwight, *Auk*, 1902, p. 248), but our binomial and trinomial nomenclature is used only for specific or other racial variations.

Among terrestrial vertebrates racial variation corresponds closely to geographic environment, and in many groups it is very easy to recognize the effect of the environment of several different life areas in producing recognizably distinct races from the same type.

In birds and mammals this correspondence is most marked, though among them we find some genera much more plastic than others; the song sparrows (*Melospiza*), for instance, breaking up into a very large number of forms, while the robins (*Merula*) are remarkably constant over large areas. In birds and mammals the individual variation in size, after making due allowance for age and sex, is exceedingly slight, and the same may be said of color, provided the additional allowance for season is made, so that very slight differences in measurements or in shades of color, which might appear trivial, are really constant and perfectly reliable as indications of the differentiation of a distinct form.

Among reptiles individual variation is very much greater, and geographic races cannot be so clearly designated as in the classes just considered. Measurements are of little significance, except in the relation which one dimension may hold to another; color and scale formulæ are also subject to great variation. Some species, however, vary much more than others, and in slightly differentiated forms with a high percentage of individual variation extremes may overlap in certain respects, or an occasional individual may revert to an ancestral type in some character or other, without affecting the fact that a race has been differentiated. Such individuals are referable to the same category as geographic intergrades in the usually narrow belt, where life-areas which have given rise to two forms merge one into the other.

In the Batrachia individual variation is further complicated by the metamorphosis which is often responsible for the persistence of certain early (larval) characters in the adult, and that many species in this class have been based upon this and other individual variations I have little doubt.

In the higher terrestrial vertebrates, as already pointed out, the ranges of several closely related forms are coextensive with the limits of the several life-areas to the peculiar environmental conditions of which they owe their origin. Consequently we never find two geographic races or subspecies of the same form occurring together, except during times of migration. Among reptiles, however, we do find variants of the same form which have been generally rated as subspecies occurring in the same life-area. We perhaps need more material and more exact data regarding habitat, etc., before the proper status of such forms is established. They may be color types or dimorphic forms produced indiscriminately throughout the range of the species; or are, perhaps, due to local, soil or other conditions prevailing in different areas within the range of the species. The fact that such forms occur together and intergrade, however, seems abundantly proven.

The above *résumé* is presented, showing the conditions which exist among terrestrial vertebrates with regard to racial variation, in order that they may be compared with the conditions that prevail among plants.

Racial Variation Among Plants.

As is well known, the trees and shrubs, as well as other plants in a less degree, conform with more or less exactness to the same general laws of geographic distribution that pertain to animals; and the ranges of many species are limited by the life-zones that have been established originally from a study of birds and mammals.

When, however, a genus is represented by different forms in several life-zones, they are usually very distinct species and not closely related variants which have obviously been differentiated from a common parent type by prevailing environmental conditions in the several life-areas in question, such as is so frequently seen among vertebrates.

At the same time an abundance of closely related variants do exist among plants, differentiated to the same varying extent as in the geographic races of birds and mammals, but all occurring in the same life-zone or area, and often side by side. They are, moreover, quite constant in their racial characters, and certainly not cases of individual variation.

Obviously some other agency must be responsible for this differentiation, and it is in many cases no doubt to be found in the varying soil conditions, and in other local peculiarities not sufficiently potent to affect higher animal life. Owing to the fixed nature of plant life,

such conditions are likely to have a very marked effect in producing local forms from widely distributed species, while, on the other hand, a freely moving animal is either not so easily affected or simply avoids localities within its range where soil conditions, etc., are uncongenial. Thus the pine-barren region of southern New Jersey, where soil conditions differ totally from the lower Delaware valley, though in the same life-zone, presents a most distinctive flora, but not a single "subspecies" of bird or mammal has been differentiated from those found in the latter area. Such species as are not averse to the conditions there presented occur unchanged, while others simply avoid the region and are conspicuous by their absence. Some very local races of mammals have been differentiated, it is true, in the Dismal Swamp of Virginia and other similar spots, but the effect of purely local conditions upon plant life is vastly greater than upon animals.

My studies have been entirely too limited to warrant any attempt to account for the origin of these local plant races, even in the genus to which I have devoted especial attention, but the point that I would particularly emphasize is that we have in these forms, which grow often side by side, just as clearly differentiated races as the geographic subspecies of vertebrates, and that they can be designated by trinomials to better advantage than by the binomial method now generally in vogue, even though the grouping be admittedly arbitrary in some instances (cf. *Condor*, 1903, p. 43). The careless use of the trinomial or varietal name in botany for all sorts of variation, purely individual, albinistic, etc., of course acts as a prejudice against applying it to well-established racial forms of this kind, but with the tremendous increase in species that we have recently witnessed in some genera the benefits of the trinomial system should be apparent. Unless we are thoroughly familiar with a genus, it is impossible to tell in a strictly binomial system which forms are clearly defined species and which are slightly differentiated races of a well-known type, while the use of trinomials indicates this at a glance.

Of course, in either animals or plants there must be some limit to the number of forms recognized, and nomenclature becomes absurd when applied to variants which can only be recognized by, perhaps, one or two specialists who have devoted years to the study of the group. This limit would seem to have been passed in the genus *Cratægus*. While there are admittedly a large number of species in eastern North America, the two hundred or more that have been proposed seem to more than cover the ground, especially since I have seen sets of specimens collected from six bushes and submitted to three leading

specialists on the genus returned as belonging to twice that number of species, due to the difference in their identifications.

VARIATION IN THE GENUS VIOLA.

My observations on the genus *Viola* as represented in the neighborhood of Philadelphia have covered a number of years, but during the past three seasons the study has been carried on systematically throughout the spring and summer. Typical colonies of the various forms have been constantly under observation, and large series of specimens have been preserved at definite periods which show as nearly as possible the changes undergone by each species. These specimens will be distributed in sets to several of the principal herbaria in the East, where they may perhaps be of assistance to others who are engaged in a study of this interesting genus.

The species of the genus *Viola* are divisible at once into two groups—the caulescent species, bearing both leaves and flowers upon a main stem, and the acaulescent, in which petioles and scapes spring from the root stalk. The species of the former group are much more easily defined, and show but little of the tendency to racial variation that is characteristic of the acaulescent group. We find three types of color in the flowers of the genus—blue, yellow and white—and all are represented in each of the above groups. In one caulescent species *V. rafinesquii* the flowers are somewhat parti-colored, as in the case of the pansies of cultivation, of which this is our native representative, forming a section well distinguished from the other species by additional characters. Among the caulescent species we also have one parti-colored race, *V. pedata*, which likewise is clearly separated from the others by structural peculiarities.

It is the blue-flowered acaulescent species that present by far the greatest racial and individual variation, and it is to them that I have given particular attention, and upon which the following statements are based, though all the species are considered in the review of our local violets which concludes the paper.

Leaf-form is decidedly the most striking character in violets, and one in which variation is to be seen to perfection. There is, first of all, variation due to age, the early leaves being usually different from those produced later in the season. The general shape of the early leaves is, moreover, very similar in a number of species which later on bear but little resemblance to one another—a fact which renders it exceedingly difficult to identify some of the descriptions of older writers based solely upon early flowering plants. In forms in which

the mature leaves are lobed or cut the early leaves are often quite or nearly entire, indicating the probable derivation of lobed-leafed species from an entire-leaved ancestor; and the tendency toward lobation seems to increase in all the later leaves.

Considering now the racial variations presented by the leaves, we find a tendency in two directions, starting from what I take to be the most primitive type—the cordate leaf of *V. papilionacea*, etc. In one direction we tend toward extreme lobing or leaf division, passing successively through *V. palmata dilatata*, *V. palmata*, *V. p. variabilis*, *V. p. angellæ*, *V. septemloba* and *V. brittoniana*, culminating with the aberrant *V. pedata*, in which the lobation is of a somewhat different type.

In the other direction, we pass through *V. fimbriatula* and its forms to the triangular-leaved *V. emarginata* and the narrow sagittate-leaved *V. sagittata*. This series has a tendency to toothed or notched bases to the leaves, and in very broad-leaved *V. emarginata* these teeth are exaggerated into lobes and a leaf-form is produced that comes very close to some of the *V. palmata* group near the other end of the series!

Individual variation is best shown in *V. p. dilatata* and *V. p. variabilis*. In these we are likely to find every variation, from a plain cordate leaf to one with from three to seven lobes, in the same colony of plants, and many of them actually on the same individual plant. Sometimes, too, we find leaves lobed on one side and not on the other. That these all belong to one race is certain, though the unlobed type has often been regarded as distinct under the name of *V. sororia*. That one style of leaf may prevail in one locality and another somewhere else seems quite likely, though all the colonies that I have examined exhibit a great variety of shapes.

So far as the correlation of the lobed-leaved species with peculiar soil conditions, there seems to be only contrary evidence. The *V. palmata* group are plants of the upland woods, *V. septemloba* is a moist-woodland violet and *V. brittoniana* occurs in open sandy ground, usually in moist spots, while *V. pedata* is a plant of dry sandy banks.

There does, however, seem to be a tendency toward narrow leaves in many wet-ground species, as seen in the linear divisions of *V. brittoniana* and the lanceolate leaves of *V. lanceolata* and *sagittata*.

In the pubescence of the leaves we have a pretty good specific character, though it seems to decrease somewhat on very old leaves, while very early leaves of *V. p. dilatata* are nearly glabrous, though the later ones are strongly pubescent. In *V. sagittata* some colonies have slightly pubescent leaves, while the typical plants are glabrous.

V. fimbriatula and its forms, the most pubescent species of the genus, are always found on exposed dry sandy or rocky banks, but *V. villosa* and *V. palmata*, also pubescent, are woodland species, and grow closely associated with *V. affinis*, which is glabrous. It may be said, however, that all species of moist, open ground are essentially glabrous, viz., *V. cucullata*, *V. crenulata* and typical *V. sagittata*.

The relative length of petioles and scapes is often quoted as a distinctive character, but such comparison should explicitly be made with either the first or second set of leaves, as the "flowering period" often covers the growth of the second leaves, so that early flowers are longer than the leaves while later ones are shorter. The length and character of the peduncle of the later cleistogamic flowers is an important specific character, as first pointed out by Prof. Greene. In some species it is long and erect, notably in *V. cucullata;* in others horizontal, and in others still very short and decurved and usually hypogæous. Except that in all wet-meadow species the cleistogenes are erect, we can make no correlation between their condition and the nature of their habitat, for in some forms that do not grow in wet spots, as *V. emarginata*, they are equally erect, while in other dry-ground species they vary much in length.

In floral characters violets seem to present a great amount of individual variation, but the difficulty of preserving the blossoms makes satisfactory comparisons on a large scale practically impossible. While a certain tint of blue or purple is characteristic of each form, there is also a good deal of individual variation. The marsh forms of the *V. cucullata* group are all pale blue, but the only colony of *V. emarginata* that I have studied in flower were almost as pale, though the species grows in dry, sandy situations. On the other hand, *V. sagittata*, from wet meadows, has as dark purple flowers as we find in *V. villosa* of the dry woodlands, so that in color also we find little correspondence with immediate environment.

The extent of pubescence on the petals is an important specific character, and varies from *V. septemloba*, where it is confined to the bases of the lateral petals, to *V. sagittata*, in which it usually spreads to some extent over all, though sometimes absent from the two uppermost.

As to relative time of flowering in the vicinity of Philadelphia, *V. fimbriatula*, *villosa* and *affinis* are the earliest, and are about over when *cucullata* and *dilatata* come into bloom, the difference being about two weeks; the other acaulescent blue species begin to blossom about midway between these two groups.

With regard to geographic distribution of the forms of violets, both caulescent and acaulescent, that I have identified in eastern Pennsylvania and southern New Jersey, six are characteristic boreal species, being found abundantly in the highest mountain districts, where the fauna is decidedly Canadian. Of these *V. canadensis*, *V. selkirki*, *V. renifolia* are restricted to this region, but *V. rostrata*, *V. leconteana* and *V. roundifolia* extend much farther south in suitable locations, the last two reaching the southeastern corner of Pennsylvania. *V. muhlenbergii*, *V. cucullata* and *V. scabriuscula* also occur in the higher Alleghanies, but are equally as plentiful about Philadelphia.

Another group of species seems to be decidedly southern, and is limited to the low grounds of the lower Delaware and Susquehanna valleys or the coastal region of New Jersey, in the Carolinian faunal belt, viz., *V. brittoniana*, *V. lanceolata*, *V. septemloba* and *V. rafinesquii*.

The other forms, including the various forms of *V. palmata* and *fimbriatula*, seem to range indiscriminately over the intervening country, most of them spreading over the habitat of the last group as well.

The Violets of Philadelphia and Vicinity.

The following synopsis is the result of several years' study, during which time a series of several thousand specimens has been collected and preserved and many observations upon living plants recorded. Undoubtedly further investigations will detect additional forms, and this list is not claimed to be complete but rather a basis for future work, in the belief that local studies of the genus will aid us in eventually gaining a better understanding of its species.

In the identification of the species I have to express my deep indebtedness to Prof. Edward L. Greene, the leading authority on the genus, who very kindly examined a series of my specimens and gave me his views upon their relationship, and also to Mr. Charles Louis Pollard, who has from time to time identified specimens for me. The types of Nuttall, Schweinitz and Muhlenberg in the herbarium of the Academy have thrown much light on the application of some of the older names.

We may consider the species in two main groups:

I. Acaulescent species, leaf petioles and flower scapes both arising from the root-stalk (p. 665).

II. Caulescent species, with a leafy stem upon which the flowers are produced (p. 686).

I. *Acaulescent Species.*

I.—Plants producing stolons after the flowering season.
a.—Flowers yellow, ... *V. rotundifolia.*
aa.—Flowers white.
b.—Leaves cordate at base, cleistogenes on horizontal peduncles.
c.—Petioles and scapes spotted with red, *V. leconteana.*
cc.—Petioles and scapes unspotted, . . . *V. blanda.*
bb.—Leaves decurrent on the petiole, cleistogenes erect.
c.—Leaves oval, ... *V. ovata.*
cc.—Leaves lanceolate, ... *V. lanceolata.*
II.—Plants not stoloniferous, flowers blue.
a.—Leaves more or less lobed or cut.
b.—Leaves and petioles pubescent.
c.—Lobes not deeply cut, only about half-way to the base, *V. palmata.*
cc.—Lobes deeply cut, nearly to the base, *V. p. dilatata, variabilis* and *angellæ.*
bb.—Leaves and petioles nearly or quite glabrous.
c.—Middle lobe undivided, no cleistogenes, *V. pedata* and subsp.
cc.—Middle lobe divided in three, cleistogenes present.
d.—Leaves large; lobes broad, much narrowed at base, ... *V. septemloba.*
dd.—Leaves medium, lobes nearly linear, *V. brittoniana.*
aa.—Leaves not lobed, never coarsely toothed or sagittate at the base.
b.—Leaves strongly hispid-pubescent above, glabrous below and on petiole, ... *V. villosa cordifolia.*
bb.—Leaves pubescent, on blade and petiole, cf. *V. palmata dilatata* and *V. fimbriatula aberrans.*
bbb.—Leaves glabrous or very nearly so.
c.—Cleistogenes on erect pedicels.
d.—Leaves cordate-ovate, plants medium or large, *V. cucullata* and subsp.
dd.—Leaves nearly triangular, plants small, *V. crenulata.*
cc.—Cleistogenes deflexed or horizontal.
d.—Leaves broadly cordate or reniform, apex not produced, flowers deep purple, *V. papilionacea.*
dd.—Leaves more triangular, apex attenuate, flowers pale lilac, ... *V. affinis.*
aaa.—Leaves sagittate, triangular or oval, usually with several coarse teeth at the base.
Leaves sagittate, usually glabrous, ... *V. sagittata.*
Leaves oval, or with truncate base, strongly pubescent, *V. fimbriatula.*
Leaves triangular, thick, fleshy, glabrous, . *V. emarginata*

The yellow and white acaulescent violets in the vicinity of Philadelphia are referable to five described species, all of which are sharply separated with the exception of the *blanda-leconteana* group, which will upon further study undoubtedly resolve itself into several well-marked races. In fact, Prof. Greene tells me that the violet here described as *V. blanda* is certainly not typical of that species, but as it is not my intention here to propose any new names, I let it stand pending a more exhaustive study of this group.

The blue-flowered species, as already stated, constitute the most puzzling group of the genus. Apart from the aberrant *V. pedata*, the species fall naturally into three sections typified by *V. papilionacea* (Pls. XXXI–XXXII), *palmata* (Pl. XXXIII–XXXV) and *fimbriatula* (Pl. XXXVI–XXXVII), though it must be confessed that *V. villosa* is practically midway between the first and second groups, and that some forms of *V. emarginata* recall the *V. palmata* group. *V. selkirki*, of the high Alleghanies, stands quite apart with more the habit of the white-flowered species.

1. Viola rotundifolia Michaux.

Viola rotundifolia Michaux, 1803, Flora Bor. Amer., II, p. 150.
Viola clandestina Pursh, 1814, Flora Am. Sept., I, p. 173.

Range.—Mountainous regions extending southward in suitable locations, reaching the valleys of Wissahickon and Crum creeks in Philadelphia and Delaware counties, where it occurs sparingly, and at one or two points in Montgomery county along the Schuylkill. In New Jersey, according to Dr. Britton's *Catalogue*, it reaches the lower part of Hunterdon and upper Monmouth counties. In its southernmost stations it usually grows under hemlocks, which are the prevalent trees in the true home of the species in the mountains.

Habitat.—Damp banks in deep shade.

Description.—Early flowering plant. Crum creek, Delaware county, Pa., April 13, 1902. No. 2,537, Herb. W. S. Flowers bright yellow, lateral and lower petals with fine dark brown lines, which in the former are confined to the lower edge, and immediately above them is a small patch of white hairs; sepals linear, oblong, obtuse; scape 60 mm. long, almost glabrous. Leaves involute, not yet expanded, and in some instances scarcely visible above the ground, pale green, 25 x 30 mm., crenate, minutely puberulent above, petiole 30 mm., slightly pubescent, or in very young leaves glabrous. Fruiting plant, Crum creek, May 30, 1901. No. 1,180, Herb. W. S. Scape 45 mm., capsule 8 mm., segments keeled. Leaves flat on the ground, ovate, the latest ones orbicular, 80 x 60 mm., crenate, light green above with minute scattered hairs,

pale and glabrous beneath, except on the basal part of the midrib which, with the petiole (60 mm.), is distinctly pubescent. These specimens bear "stolons" 100 mm. long, which I have not found rooting, but which bear several small lanceolate bracts and a leaf 25 x 35 mm., with several cleistogenes on very short pedicels. Still later specimens, August 4, have the leaves darker green and nearly or quite glabrous, as are the petioles; cleistogenes in fruit, nearly ripe.

2. Viola blanda Willd.

Viola blanda Willdenow, 1806, Hortus Berolien. Pl. XXIV.

Range.—Through southeastern Pennsylvania and southern New Jersey, west of the pine barrens; the records of its occurrence toward the mountains are in part confused with *V. leconteana.* Rather local, though not rare about Philadelphia.

Habitat.—Low woodlands in moist ground along streams; usually growing in large colonies.

Description.— Early flowering plant. Sherwood, Philadelphia, April 10, 1903. No. 5,159, Herb. W. S. Root-stalk slender with dried stolons of previous year still adherent. Flowers white, somewhat fragrant, 10 mm. broad, lower petal heavily lined with dark purple and lateral petals with two or three lines, all glabrous; sepals lanceolate, acute. Leaves thin, lighter beneath, glabrous; crenate, orbicular or the earliest reniform, cordate at base, 25 x 30 mm.; petioles 40 mm., glabrous.

Fruiting plants, Sherwood, June 17, 1903. No. 5,160, Herb. W. S. Leaves very thin, with a few scattered hairs above and on the veins beneath, size 80 x 90 mm.; petioles glabrous, 180 mm. long. Stolons very slender, 130 mm., still without leaves. Cleistogenes on some plants only, and very slender, their scapes 15 mm. long, horizontal. In later specimens, August 18, from Chester county, Pennsylvania, the stolons bear small leaves and a few minute cleistogenes. The sinus becomes much more open in the late summer leaves.

3. Viola leconteana Don.

Viola amoena Le Conte, 1828, Ann. Lyc. N. Y., II, p. 144 (*nec* Symonds, 1798).
Viola leconteana Don, 1831, Gen. Syst., I, p. 324.
Viola alsophila Greene, 1899, Pittonia, IV, p. 7.

Range.—Abundant in the mountains, extending southward in cold rocky woods to the lower Susquehanna in York and Lancaster counties, and the Brandywine below Chadd's Ford, Delaware county.

Habitat usually on damp shady rocky banks, though in the mountains it is found pretty generally throughout the forests, and is the most abundant violet.

Description.—Specimen in full flower. Chadd's Ford, May 10, 1902, B. H. Smith. No. 5,172, Herb. W. S. Flowers similar to the last, but 15 mm. broad; scapes 100 mm. long, spotted with red. Earliest leaves 25 x 25 mm., reniform, orbicular or somewhat ovate; later leaves ovate, 40 x 50 mm., slightly pubescent above, glabrous below: petioles red-spotted, 50 mm. long, glabrous. Scapes of the cleistogenes 25 mm. in length. Late summer fruiting plants have the leaves all ovate, usually rather acuminate, but they do not exceed 50 x 60 mm. in size; petioles, however, vary to 150 mm. in length.

As already stated, this and the preceding need more careful study, but I have not the necessary material at hand.

In the higher Alleghanies (Sullivan and Wyoming counties, also Fulton—Porter), *Viola renifolia* Gray grows with *V. leconteana*, and in its later stages bears considerable resemblance to it, as the leaves often become decidedly ovate in outline. The bristly pubescence of the petiole and veins on the under surface of the leaf, however, are in marked contrast to the smoothness of these parts in *V. leconteana*, while the upper surface in *V. renifolia* at this season is glabrous, instead of sparsely pubescent, as in the other species.

V. leconteana seems to be the most stoloniferous of any of the white acaulescent violets, but all of the *blanda* group exceed *V. primulæfolia* and *lanceolata* in this respect.

4. Viola primulæfolia Linn.

Viola primulæfolia Linn., 1753, Sp. Plant., pl. 934.
Viola p. boscii D. C., 1824, Prodromus, I, p. 293.
Viola p. cordata D. C., 1824, Prodromus, I, p. 293.

Range.—The southeastern counties of Pennsylvania, as well as in boggy places in Monroe county, and abundant in southern New Jersey, except the pine barrens, where it is replaced very largely by the next.

Habitat.—Open moist ground.

Description.—Early flowering plant. Tinicum, Delaware county, Pennsylvania, April 25, 1903. No. 5,153, Herb. W. S. Flowers white, 10 mm. broad, the lower petal strongly, the laterals slightly veined with dark purple, all glabrous; sepals lanceolate-acute; scape 40 mm., glabrous. Leaf ovate-oblong or oval, base decurrent; crenulate, 15 x 20 to 20 x 25 mm., glabrous, except base of midvein beneath and petiole which are pubescent, petiole 10 to 15 mm.

Older flowering plant. Tinicum, May 9. No. 5,154, Herb. W. S. Scapes 90 mm. Leaves almost or quite glabrous thoughout, 35 x 23 mm., petiole 40 mm. Cleistogenes erect on scapes 20 mm. long.

Fruiting plant. Tinicum, June 21, 1903. No. 5,155, Herb. W. S.

uiting scapes 140 mm. long. Leaves 50 x 70, glabrous; petioles 150 m. long, glabrous or with a few scattered hairs. Stolons just sprout- g, 50 to 60 mm. long. In July and August specimens the stolons ar leaves 20 x 25 mm. on petioles 50 mm. in length, as well as small eistogenes. In specimens from Willow Grove, Montgomery county, nnsylvania, the main leaves reach the dimensions of 60 x 100 mm. . petioles 160 mm. in length, while the erect cleistogenes are on ıbescent scapes 80 mm. long.

This species and the next are open-bog or wet-meadow violets, rming a very distinct group from the woodland, rocky-bank species iich precede; and seem to be the southern representatives of the *inda* group. We have thus two austral species and three boreal es, the members of each group more closely related *inter se* than ey are to any species of the other group. Among vertebrates in a nilarly distributed lot of forms we should expect to find boreal and stral derivatives of the several types, but as before stated, in plants seem to find that the most recent differentiations have taken place *thin* the same life-zone, and that they are not zonal in their origin or stribution.

Viola lanceolata Linn.

Viola lanceolata Linn., 1753, Sp. Plant., pl. 953.
Viola attenuata "Sweet" Don, 1831, Gen. Syst., I, p. 322.

Range.—The southeastern counties of Pennsylvania, mainly along e Delaware and Susquehanna (also Monroe county—Porter), and undant throughout southern New Jersey, where it is the most char- teristic species of the pine-barren bogs, also up the Delaware to arren county (Britton). About Philadelphia it is found only in the w grounds along the Delaware.

Habitat.—Wet open bogs or meadows, often growing with *V. pri- ulæfolia*, and sometimes approaching it in early leaf-forms, but the wers are always larger, and the later leaves abundantly distinct.

Description.—Early flowering plant. Tinicum, Delaware county, nnsylvania, May 9, 1903. No. 5,156, Herb. W. S. Flowers 15 mm. de, white, the lower petal strongly purple-veined, the laterals with e or two streaks; glabrous; sepals narrowly linear, acute, scapes abrous, 100 mm. long. Leaves ovate-lanceolate, decurrent at base, x 12 mm., obscurely crenulate glabrous, petioles glabrous, 30–40 m. Cleistogenes on scapes 30 mm. long.

Later plants have leaves lanceolate, gradually decurrent, length eluding petiole 175 mm., width 15 mm. Flower scapes 170 mm.

Fruiting plant. Tinicum, June 28, 1903. No. 5,157, Herb. W. S.

Fruiting scapes 110 mm. Total length of leaves 180–320 mm., width 20–30 mm. Stolons 100 mm. in length on some plants bearing typical leaves and minute cleistogenes.

Viola sekirkii "Pursh" Goldie, which in foliage and general appearance resemble the *blanda* group, but differs in its pale blue flowers, grows plentifully in damp rocky situations in the hemlock forests of Sullivan and Wyoming counties, Pennsylvania, on the North Mountain; and has also been found in Monroe and Somerset counties (Porter).

6. Viola papilionacea Pursh. (Pl. XXXII, fig. i; Pl. XXXVIII, fig. iii.)

Viola papilionacea Pursh, 1814, Flor. Amer. Sept., I, p. 173.
Viola communis Pollard, 1898, Bot. Gazette, XXVI, p. 336 (*nec* Wittrock).
Viola domestica Bicknell, 1898, in Britton and Brown, Ill. Flora, III, p. 519.
Viola obliqua Britton and Brown, 1898, Ill. Flora, II, p. 447 (*nec* Hill).

Range.—The commonest violet through eastern Pennsylvania and New Jersey, though apparently not found on the higher Alleghanies, or in the pine barrens.

Habitat.—Meadows, fields, fence-rows, etc., also in low woodland.

Description. — Early flowering plant. Sherwood, Philadelphia, April 10, 1903. No. 5,119, Herb. W. S. Root-stalk thick and ribbed. Flower 20 mm. wide, deep violet-purple ("violet" of Ridgway's *Nomenclature of Colors*), the petals white at the base, the lower and lateral ones with dark lines, the latter also with a round patch of white hairs which is confined to the white basal area, other petals glabrous; the two upper ones usually recurved; sepals ovate-lanceolate, rather blunt; scape glabrous, 60 mm. long. Leaves cucullate, cordate in outline and distinctly crenate, 25 x 30 mm., glabrous; petiole pubescent on convex side, 40 mm. in length.

Later flowering plant. Media, Delaware county, Pennsylvania, April 26, 1903. No. 5,121, Herb. W. S. Exactly like the last, but leaves 40 x 50, petioles 80 mm., and scapes 100 mm.

Fruiting specimen. Media, June 4, 1903. No.5,122, Herb. W. S. Leaves somewhat doubly crenate, 110 x 120 mm., petiole 275 mm., otherwise as before, fruiting scapes 80 mm. (apparently from cleistogenes). Other specimens, Sherwood, May 17, 1903, have cleistogenes in all stages of development on decurved peduncles 20 mm. in length, leaves 80 x 90 mm.

The general tendency in old leaves is to become widespread at the base, as contrasted with the narrow sinus of the early flowering season; and I can see no other character in *V. domestica* Bicknell that is not attributable to the rich soil of cultivated ground. Many other

species will become distinctly ranker than the wild plant when transferred to rich garden soil.

The above descriptions of *V. papilionacea* are taken from two colonies only. Many others examined agreed with them exactly in leaf characters, but a further examination may show some variation in shape of petals, extent of pubescence, etc., which I have not yet detected. The petals are usually recurved, sometimes very markedly so, as in specimens from the hilly woods bordering the Schuylkill at Gladwyn in which they are quite long and narrow. Woodland plants have usually bluer flowers.

As to the proper name for this species, I agree with Prof. Greene and Mr. Pollard in their latest decision that *papilionacea* Pursh is the earliest name based upon the present plant. It has a further advantage in apparently never having been used by subsequent authors for any other species, a decided point in its favor!

7. Viola papilionacea subsp.

I have found in dry upland woodland on Crum creek, Delaware county, a quite distinct ally of *V. papilionacea*, with a lighter rootstalk and more delicate foliage. Leaves more acuminate and rather more coarsely crenate, glabrous except for minute silvery appressed hairs scattered along the veins above; petioles glabrous, 180 mm. long; cleistogenes horizontal, not recurved; scapes 60 mm. in length. Only having fruiting specimens, May 17, 1903, No. 5,126, Herb., W. S., I am unable as yet to properly describe this form. Prof. Greene regards it as a distinct species.

8. Viola affinis Le Conte. (Pl. XXXI, fig. ii.)

Viola affinis Le Conte, 1828, Ann. Lyc. N. Y., II, p. 138.
Viola obliqua Pollard, 1901, in Britton's Manual, p. 636 (*nec* Hill).

Range.—Southeastern Pennsylvania and southern New Jersey exclusive of the pine barrens, apparently not extending to the mountains.

Habitat.—Rich woodlands.

Description.—Early flowering plant. Sherwood, Philadelphia, April 19, 1903. No. 5,103, Herb. W. S. Flowers 20 mm. in diameter, pale lilac ("lilac" of Ridgway), deepening into blue just at the junction with the white throat, darker purple veins on lower and lateral petals, bearding on lateral petals not entirely confined to the white area, but extending a little way on to the blue; lower petals slightly hairy at base; sepals ovate-lanceolate, acuminate; scapes 60–70 mm. long, glabrous. Leaves rather light green, somewhat cucullate; cordate, or

usually nearly triangular, 20 x 25 mm., rather coarsely crenate, glabrous; petioles 40–50 mm., glabrous.

Later specimens, Sherwood, April 29, 1903. No. 5,104, Herb. W. S. Scapes 70–100 mm. Leaves 30 x 40, wider at base and more attenuate at apex, cucullate and coarsely crenate, petioles 60–90 mm. A few cleistogenes present on scapes 25 mm. long.

Fruiting plants, Sherwood, June 17, 1903. No. 5,105, Herb. W. S. Leaves 70 x 80, coarsely and irregularly crenate-dentate, sometimes with very minute silvery hairs scattered on the veins above; petioles 160 mm., glabrous. Cleistogenes obliquely ascending or later deflexed, peduncles not more than 50 mm. long.

This species is well characterized by its general slenderness, thin, glabrous leaves, with coarsely crenate margins and pale flowers. At Sherwood it grows with *V. villosa cordifolia* and *V. palmata dilatata* in about equal abundance, and the three can be distinguished at a glance by foliage alone—*V. affinis* always glabrous, *V. villosa cordifolia* almost hispid-pubescent above, but glabrous beneath and on the petioles, and *V. p. dilatata* pubescent all over.

I would strongly advocate the use of Le Conte's name *affinis* for this violet. We not only know that this is what he had in view, but the name has been conceded to this species ever since its resurrection until Mr. Pollard, in Britton's *Manual*, foisted the old much-abused name *obliqua* of Hill upon it. Nobody knows what Hill's *obliqua* is, and the fact that no two persons seem to agree is argument enough that it should be discarded as unrecognizable along with *cordata* Walter and some others. Many other old names are difficult to identify with certainty, but where successive authorities have been in general agreement there is strong ground for their retention. To illustrate a little of the obscurity that surrounds *obliqua* of Hill, we may state that in 1896 Mr. Pollard applied it to *V. cucullata + papilionacea*. In 1898 he applied it to some form that he regarded distinct from either; then it was alloted to *V. papilionacea*, and now is again transferred to *affinis*. In marked contrast to his later views Mr. Pollard, when making his first application of the name, states that the species "is so well figured as to leave not the slightest doubt concerning the plant to which it refers." Prof. Greene, on the other hand, says "it does not half represent any violet that ever grew in any country," and calls attention to the fact that Pursh thought it applied to *V. blanda*, while Gray at one time suspected it to be *V. rotundifolia!* I give these opinions of *V. obliqua* simply to show the futility of attempting to use it in any sense.

9. Viola cucullata Ait. (Pl. XXXII, fig. ii; Pl. XXXVIII, fig. iv.)

Viola cucullata Aiton, 1789, Hortus Kewensis, III, p. 288.

Range.—Apparently throughout Pennsylvania and New Jersey, except the pine barrens, though the relative range of this and the two following has still to be worked out. One form at least occurs in the higher Alleghanies.

Habitat.—Swamps and wet meadows, often growing in the water in spring heads and shallow ditches. Plentiful about Philadelphia.

Description.—Flowering plant. Tinicum, Delaware county, Pennsylvania, May 9, 1903. No. 5,128, Herb. W. S. Flowers 20–25 mm. broad, pale blue ("campanula blue" of Ridgway) becoming darker toward the throat, which is white; lower and lateral petals lined with purple, the former glabrous, the latter with restricted patches of white beard; sepals rather long, lanceolate, acuminate; scapes glabrous, 150–180 mm. long. Leaves cucullate, cordate-ovate, crenate, glabrous, 35 x 45 mm. (the earliest more nearly orbicular, 25 x 30); petioles 80–90 mm., glabrous; peduncles of cleistogenes already 20 mm. in length.

Fruiting plant. Tinicum, May 23, 1903. No. 5,129, Herb. W. S. Leaves strongly cucullate, with very minute silvery hairs scattered along the veins above, otherwise glabrous; coarsely but regularly crenate, 70 x 75 mm.; petioles 260 mm.

Fruiting scapes and cleistogenes 225–300 mm. long. Some later fruiting cleistogenes (June 28) have peduncles 350 mm. in length.

This species is distinguished by its very long flower scapes and the enormous length attained by both scapes and petioles in fruiting plants. The cleistogenes are strictly erect, and the blades of the leaves never reach the size of *V. papilionacea;* the blue, not purple, flowers are also characteristic. The two races which follow are closely related, and have not yet been studied from very large series. Thinking the specimens I had might be different from *V. cucullata*—especially No. 5,132—I submitted them to Prof. Greene, and he identified them as his new species *V. macrotis* and *V. leptosepala*.

10. Viola cucullata macrotis (Greene).

Viola macrotis Greene, 1902, Pittonia, V, p. 97.

Range.—Shady swampy spots in western New Jersey, between the pine barrens and the Delaware; doubtless elsewhere as well.

Description.—Flowering plants, Medford, New Jersey, May 5, 1903. No. 1004, Herb. W. S. Similar to *cucullata*, but flowers larger; petals very broad; leaves usually with larger blades, less cucullate and thinner; sepals minutely ciliate on the margins, and scapes and petioles often with a few scattered hairs.

11. Viola cucullata leptosepala (Greene).

Viola leptosepala Greene, 1902, Pittonia, V, p. 98.

Range.—Shady bogs, western New Jersey; probably more extended.

Description.—Flowering plants, Springvale, Camden county, New Jersey, May 10, 1903. No. 5,132, Herb. W. S. Generally similar to *cucullata*, but much more slender and delicate and plants solitary; leaves more elongate; flowers large, with remarkably long, slender sepals, 12 mm. long and less than 2 in width. Scapes and petioles very slender and with scattered hairs, most plentiful on the lower part.

12. Viola crenulata Greene. (Pl. XXXII, fig. iii.)

Viola crenulata Greene, 1901, Pittonia, IV, p. 295.

Range.—Only detected in Tinicum, Delaware county, Pennsylvania, as yet.

Habitat.—Open wet meadows and swamps, but in drier spots than *V. cucullata*.

Description.—Flowering plant. Tinicum, Delaware county, Pennsylvania, April 25, 1903. No. 5,127, Herb., W. S. Flowers pale lilac-blue, darker near the base of the petals, throat white, 12 mm. in diameter; petals slender, the lower rather broad, slightly pubescent at base: laterals with conspicuous bearded patch; sepals slender lanceolate; scapes 80 mm., glabrous. Leaves triangular-cordate, much attenuated at apex, pale green, glabrous, except for very minute appressed scattered hairs on the veins above, size 20 x 28, coarsely crenate (earliest leaves less pointed); petioles 50 mm.; cleistogenes already 25 mm. high.

Late summer plants (August 15, 1903), past the fruiting stage, have leaves 35 x 40, but otherwise exactly like the earlier ones; petioles 90 mm. long, which evidently represents the maximum growth of this little plant.

This delicate little violet, while related to the *cucullata* group, is very distinct, differing in the color of both flowers and leaves, in the shape of the latter and the very small size, being smaller in late summer than *V. cucullata* when it is in early flower. The April specimens above described had evidently been in flower some time, as evidenced by the development of the cleistogenes.

13. Viola villosa cordifolia Nutt. (Pl. XXXI, fig. i.)

Viola villosa cordifolia Nuttall, 1818, Genera, I, p. 148.
Viola sororia nuttallii Don, 1831, Gen. Syst., I, p. 324.
Viola cucullata var. *cordata* Gray, Manual, 5th ed., p. 78, in part (prob. not *cordata* Walter).
Viola ciliata Muhl., 1813, Cat., p. 26.

Range.—Pennsylvania, apparently not extending to the higher

mountains; the northern and middle counties of New Jersey, and rarely in Camden county, but not in the pine barrens.

Habitat.—High dry woodland.

Description.—Early flowering plant. Sherwood, Philadelphia, April 10, 1903. No. 5,100 Herb. W. S. Flowers red-purple (near "aster-purple" of Ridgway), white in the throat; but slightly veined; upper petals rounded, not at all recurved; lateral petals bearded near the base, as in *affinis*, but lower petal often nearly glabrous; width of flowers 15–18 mm.; sepals lanceolate or ovate-lanceolate, rather obtuse; scapes 40–50 mm., glabrous. Leaves dark green, silvery-pubescent above, glabrous and reddish beneath, and frequently prostrate on the ground; reniform orbicular or cordate, crenate, 20 x 25 mm.; petioles 30–40 mm., glabrous and reddish at base. Later specimens, April 29, have leaves ovate-cordate, 25 x 35 mm., and bear horizontal cleistogenes on peduncles 30 mm. long.

Fruiting plant, Sherwood, June 17, 1903. No. 5,102, Herb., W. S. Leaves round-cordate, 65 x 70 mm.; petioles 110 mm. long; fruiting scapes 60 mm. These later leaves are usually erect, and not prostrate like the earliest ones, and are sometimes slightly cucullate.

This violet is at all times distinguished by the almost bristly, silvery-pubescence on the upper surface of the leaves and by its dark reddish-purple flowers. There would seem to be two separable forms confused under the name *villosa*, as Prof. Greene tells me that the plant I have described above is not true *villosa*, to which I had unhesitatingly referred it, and states that he knows both plants well. The type of *villosa* came from South Carolina, and if the form found there is distinct from the present plant, Walter's name unquestionably belongs to it. Nuttall seems to have been the only writer to recognize two forms of this type of violet, and he based his *V. cordifolia* upon specimens from "dry woods on the banks of the Schuylkill near Philadelphia." That his description applies to the above plant seems to me beyond question, and I have, therefore, adopted it.

An examination of Muhlenberg's herbarium shows that his *V. ciliata* is either the above or true *villosa*. That his names as they stand are mere *nomina nuda* is emphasized by the general assumption that in this instance he had *V. fimbriatula* in mind!

14. Viola palmata Linn. (Pl. XXXIV, fig. i; Pl. XXXIX, fig. i.)

Viola palmata Linnæus, 1753, Sp. Plant., p. 933.

Range.—So far detected only in Tinicum township, Delaware county, and near Valley Forge, Pennsylvania.

Habitat.—Dry, shaded localities.

Description.—Flowering plant. Tinicum, Delaware county, Pennsylvania, May 3, 1902. No. 2,601, Herb. W. S. Flowers large, 25 mm. broad, deep violet-purple, conspicuously bluer toward the base of the petals, which is white; pubescence restricted to white area on lateral petals; lower petal glabrous; sepals ovate-lanceolate, broad, and rather blunt; scapes slightly pubescent, 120 mm. long. Leaves moderately pubescent above and below; earliest 20 x 25 mm., later ones 45 x 50 mm.; much lobed, but none of the incisions reaching more than half-way to the base; petioles pubescent, 90–120 mm.; cleistogenes on short horizontal peduncles 30 mm. long.

Later plants, June 28, similar, but leaves nearly glabrous, except on the veins beneath, size 80 x 110 mm.; petioles 180, cleistogenes short, deflexed. Late summer leaves reach the dimensions of 120 x 150 mm., with petioles 300 mm. in length.

The apparent rarity of this violet would make me hesitate in regarding it as a separate form were it not for its very distinct characters and the assurance of Prof. Greene. Probably I have not yet discovered its stronghold, or perhaps it is rare in the vicinity of Philadelphia, but plentiful elsewhere.

15. Viola palmata dilatata Ell. (Pl. XXXIII; Pl. XXXIX, figs. iv and v.)

Viola palmata dilatata Elliot, 1817, Bot. of S. C. and Ga., I, p. 300.
?*Viola palmata fragrans* Elliot, 1817, Bot. of S. C. and Ga., I, p. 300.
?*Viola palmata vulgaris* Elliot, 1817, Bot. of S. C. and Ga., I, p. 300.
?*Viola palmata esculenta* Elliot, 1817, Bot. of S. C. and Ga., I, p. 300.
Viola heterophylla Muhl., 1813, Cat., p. 25 (*nec* Poiret).
Viola triloba Schw., 1822, Amer. Jour. Sci., V, p. 57.
?*Viola congener* Le Conte, 1828, Ann. Lyc. N. Y., II, p. 140.
?*Viola sororia* Willdenow, 1806, Hort. Berol., Pl. LXXII.
Viola asarifolia Pursh, 1814, Flor. Am. Sept., Suppl., p. 732 (*nec* Muhlenberg).

Range.—Eastern Pennsylvania and New Jersey exclusive of the pine barrens.

Habitat.—Dry upland or sandy woods and shady localities.

Description.—Early flowering plant. Sherwood, Philadelphia, April 29, 1903. No. 5,106, Herb. W. S. Flowers large, rich purple, with darker lines on lower petals, white at base of petals; pubescence in rounded patch in white area on lateral petals; lower petal slightly pubescent at base; width of flower 20 mm.; sepals broadly ovate-lanceolate, rather blunt; scapes glabrous, 50–70 mm. long. Leaves 30 x 35 mm., cordate, coarsely crenate or variously 3- to 5-lobed, divisions not usually deeply cut; pubescent on both sides as well as the petioles, which are 40–50 mm. long.

Later plants, Sherwood, May 17, 1903. No. 5,107, Herb. W. S.

Similar leaves 50 x 60 mm.; petioles 100–110 mm.; scapes 90–100 mm.; cleistogenes horizontal or slightly ascending, 20–40 mm. long.

Fruiting plants, June 17, 70 x 80–80 x 100 mm.; petioles 225 mm. long, fruiting cleistogenes 50–60 mm. long.

A glance at Pl. XXXIII will show to what extent the leaves of this violet vary; all sorts of forms may occur on one plant, or we may have plants with the leaves all uncut.

The latter are supposed to be the basis of Willdenow's *Viola sororia*. I fail to see, however, on what grounds this can be regarded as a separable form, even as a subspecies, as is done in Britton's *Manual*. On the other hand, if we regard it as the same as *dilatata*, it must supersede it, being an older name. To my mind the same arguments apply here as in the case of *V. obliqua* Hill. Nobody can ascertain what the original plant was, and in view of the various uses to which the name has been put, it had best be discarded as unrecognizable.

The several other varieties given by Elliot are probably not separable from this, and Schweinitz specimens which I have examined prove his *triloba* to be the same thing, while *heterophylla* Muhl. and *asarifolia* Pursh, while probable referable to this, are neither of them available. This is one of the most common woodland violets found about Philadelphia, and may be recognized from any (except the next) by its uniform pubescence, which is especially marked on very young leaves, though disappearing to some extent on the large foliage of late summer.

16. Viola palmata variabilis (Greene).

Viola variabilis Greene, 1902, Pittonia, V, p. 91.

Range.—Apparently higher ground, nearer to the mountains or foothills.

Habitat.—Dry woodlands.

Description.—A close ally of the preceding, but smaller and much more pubescent, quite villose on young leaves. Flowers similar but leaves more deeply divided and with fewer uncut leaves. Specimens from Argus, Bucks county, Pennsylvania, May 8, 1903, Stewardson Brown, No. 5,110, and June 8, Dr. C. D. Fretz, No. 5,111, Herb. W. S.

These plants have been identified as *V. variabilis* by Prof. Greene, while the former, which I have called *dilatata*, he considers not sufficiently pubescent and in other ways unlike this form. It may be that further study with more material may show that they are not distinguishable.

17. Viola palmata angellæ (Pollard). (Pl. XXXIV, fig. ii.)

Viola angellæ Pollard, 1902, Torreya, II, No. 2, p. 24.

Range.—Found so far only in the neighborhood of Cheyney, Chester county, Pennsylvania.

Habitat.—Rich woodland.

This violet (No. 3,094, Herb., W. S.) I collected on June 22, 1902, it being then well past the flowering stage. Comparison with typical specimens from Orange, New Jersey, kindly sent me by Miss Lillie Angell, seems to prove the identity of the two, and Prof. Greene coincides with my identification. All the leaves, even the earliest (which are still retained), are cut, the later ones having the incisions rather rounded at the base, and the lobes, except the middle, are quite uniform. The difference in the appearance of the leaves between this and the other forms can be seen by comparing the figures on the plate. The petioles and the veins on the under side of the leaf are quite pubescent, but the upper surface is but slightly so. Leaves 70 x 75 mm.; petioles 150–175 mm. long. Cleistogenes on deflexed or prostrate peduncles 20 mm. in length.

18. Viola septemloba Le Conte. (Pl. XXXV, fig. ii; Pl. XXXIX, fig. iii.)

Viola septemloba Le Conte, 1828, Ann. Lyc. N. Y., II, p. 141.

Range.—Apparently a southern species, ranging across the southern border of Pennsylvania. I have it from Kennett Square and several miles north of Coatesville, both in Chester county.

Habitat.—Low moist woodland.

Description.—Flowering plants. Kennett Square, May 7, 1903, C. J. Pennock. No. 5,112, Herb. W. S. Flowers very large, 25 mm. broad, violet-purple, distinctly darker blue near the base of the petals, white basal area well developed; upper petals particularly large, 10 x 20 mm.; lower petals glabrous and beard on laterals short and restricted; sepals very broad and relatively short; scapes 125 mm. long, glabrous. Leaves all deeply cut, except some of the earliest, in which the indentations are slight; segments of the later leaves taper rapidly to scarcely more than a millimeter in width at base; 7 to 9 principal divisions; earliest leaves 30 x 35, later 50 x 60 mm., glabrous, except for a fringe of very minute hairs on the later leaves; petioles respectively 50 and 120 mm., glabrous; cleistogenes 30 mm. long.

Fruiting specimens. Kennett Square, May 25, 1902. No. 5,113, Herb. W. S. Leaves 90 x 100 mm., with some very minute hairs above and on the margin, but appearing glabrous; petioles 320 mm. long, glabrous; cleistogenes in fruit on peduncles 100 mm. long.

This beautiful and distinct violet I have long considered to be

Le Conte's *septemloba*, a species not recognized in any of our manuals, and I am much gratified to have Prof. Greene's endorsement and statement that it matches well the water-color drawing of Le Conte in his possession.

Its large flowers, only matched by *V. brittoniana*, its peculiarly lobed, essentially glabrous leaves, and its great size in late summer—some plants measure 15 inches in height—serve easily to distinguish it from any other violet.

19. Viola brittoniana Pollard. (Pl. XXXV, fig. i; Pl. XXXIX, fig. ii.)

Viola atlantica Britton, 1897, Bull. Torrey Bot. Club, XXIV, p. 92 (*nec atlantica* Pomel, 1874).
Viola brittoniana Pollard, 1898, Bot. Gazette, XXVI, p. 332.

Range.—All along the New Jersey coast, and at points in the southern pine barrens (Egg Harbor and Tuckahoe), also up the Delaware valley, occurring at Springdale, Camden county, New Jersey, and Tullytown, Bucks county, Pennsylvania.

Habitat.—Damp, sandy, open ground.

Description.—Flowering plant. Springdale, New Jersey, May 10, 1903. No. 5,114, Herb. W. S. Flowers very large, 28 mm. across, rich violet, inclining to lilac (somewhat lighter than Ridgway's "aster-purple"), without any deeper blue tint near the base of the petals, such as is found in the preceding cut-leaved species; white area of the throat extended especially on the upper petals, pubescence on lateral and lower petals short but spreading out beyond the white area, a scattering of hairs on the upper petals as well, sepals narrowly lanceolate-acute; scape glabrous, 125 mm. in length. Leaves all much divided, earliest ones reddish beneath, divisions extending about three-quarters of the distance to the base, middle segment much broader than the others, size 30 x 30 mm.; later leaves divided to the base into three segments, and each of these again divided almost to the base, making nine irregularly toothed, nearly equal narrow lobes; size 70 x 75. The leaves appear glabrous, but have a scattering of exceedingly minute hairs, scarcely discernible to the naked eye, on the upper surface and margin; the later leaves are decidedly cucullate; petioles 90 mm. long, those of earliest leaves 30–40 mm.

Fruiting plant. Springdale, June 27, 1903. No. 5,115, Herb. W. S. Leaves 70 x 90 mm., petioles 225 mm.; cleistogenes on erect peduncles 150–200 mm. tall. The late foliage seems somewhat harsh to the touch, probably due to the minute marginal pubescence. This very distinct violet seems to have escaped the notice of all the early writers, and

had not Dr. Britton been unfortunate in selecting for it a name already used for a foreign species, it would have no synonyms. The foliage represents the extreme of the palmately cut species; some leaves have the central lobe wider than the others, but the narrow lobes are the rule, and I have yet to see an uncut leaf even among the earliest, though such a reversion is quite likely to occur occasionally in any of these violets. In the uniformly colored flowers and tall, erect cleistogenes, this species departs widely from all the foregoing.

In the Springdale colony are one or two stocks which look decidedly different, though obviously *brittoniana* in whole or in part—if we admit the possibility of occasional hybridism. These have the lobes of the leaves less deeply cut, the central lobe much wider than the others, and altogether recall strongly the extreme forms of *V. emarginata* (Pl. XXXVI, fig. v). The leaf is too round in outline for that species, but the resemblance shows how curiously interrelated these acaulescent violets are and what cases of parallel development occur. *V. brittoniana* × *V. cucullata* would, to my mind, produce just such a plant as this, and at this spot they both occur intermingled. On the other hand, it may equally as well be regarded as an aberrant form of *V. brittoniana*. The small number of plants and the association with large numbers of the other species should, to my mind, deter any one from naming such a form as this, but I fear they have not always done so in the past.

20. Viola pedata Linn.

Viola pedata Linnæus, 1753, Sp. Plant., p. 933.
Viola multifida Mill., 1768, Dict., 8 ed. (*fide* Greene).
Viola pedata atropurpurea "Raf." D. C., 1824, Prodr., I, p. 291.
Viola pedata bicolor "Pursh," "Raf." D. C., 1824, Prodr., I, p. 291 (in synonymy).

Range.—I have found this species only near Mortonville, Chester county, Pennsylvania, but have heard of it from other points in this county and Delaware. In Britton's *New Jersey Catalogue* it is recorded from Phillipsburg, Belvidere and Oxford.

Habitat.—Dry sandy banks.

Description.—Without satisfactory material, I may merely say that this differs from the next in having the upper petals deep velvety purple. There may be other differences, but I am not prepared to discuss them. I must confess, however, that I have much doubt whether this is really a distinct form from the next, as they grow so intimately intermingled. In case it is regarded as an individual variation only, then the name *pedata* will cover them both.

21. Viola pedata lineariloba D. C.

Viola pedata lineariloba D. C., 1824, Prodr., I, p. 291.
?*Viola pedata ranunculifolia* D. C., 1824, Prodr., I, p. 291.
Viola pedata inornata Greene, 1896, Pittonia, III, p. 35.

Range.—Southeastern counties of Pennsylvania and in southern New Jersey (apparently not in the typical pine barrens). To the northward it ranges to Monroe, Northampton, Lancaster and Huntingdon counties in Pennsylvania (Porter), and to several stations in the northern counties of New Jersey—Sussex, Essex, Union, Somerset, Warren and Hunterdon (Britton).

Habitat.—Dry sandy banks, or sandy open woods and clearings, necessarily local, though often very abundant. The nearest stations to Philadelphia are the serpentine outcrops of Delaware county and sandy pine woods near Springdale, New Jersey.

Description.—Early flowering plant, Media, Delaware county, Pennsylvania, April 26, 1903. No. 5,117, Herb., W. S. Flowers large, flat —*i.e.*, petals nearly in one plane—20–35 mm. in diameter, all glabrous, and without darker lines, blue (or occasionally lilac or white), stigma not bearded nor rostrate; sepals long, linear-lanceolate; scapes glabrous, 70–90 mm. (stunted plants in very barren soil have them much shorter). Leaves glabrous, all divided into 7 to 11 linear lobes. toothed at the end; the earliest leaves have the lobes less numerous and spatulate; size 15 x 18 mm.; later leaves 25 x 25 mm.; petioles 20–50 mm., glabrous.

Late fruiting plants, Media, June 4. No. 5,118, Herb., W. S. Leaves 45 x 50, petioles 100 mm. long. Fruiting scapes 80 mm. No cleistogenes are produced in this species.

The variety of size, both in plants and flowers, owing to the nature of the soil, is very great. I have specimens in full bloom in which the leaves are 2 inches high and the flowers 3, while from another locality I have plants of apparently the same age in which the leaves reach six inches and the flowers 7. Some anomalous plants collected in late summer have very broad segments to the leaf—in fact, they are sometimes reduced to coarse teeth—and are minutely pubescent. These I take to be a second crop of leaves, produced through some unusual activity, or perhaps due to arrested development in spring, since the leaves usually wither away by midsummer. Such plants have, moreover, been collected in full flower in late August and September. The lobing of *Viola pedata* and *V. p. lineariloba* is on a different plan from that exhibited in the foregoing cut-leaved species. In all palmate or pedate violets the primary division is in three parts. In *V. palmata dilatata* the process frequently stops at the trilobed stage, but in *V. sep-*

ternloba the middle segment regularly divides in three, and the lateral ones into two, while in *V. brittoniana* each segment divides into three. There are, of course, some deviations, but these are the normal types of leaf in the several species. In the *pedata* group, however, the central lobe does not divide, while the lateral ones in typical leaves are four-parted. Occasionally *V. brittoniana* comes very near to this type by producing only one lateral lobe to the middle segment, and in one leaf in my collection it is undivided. This denotes a tendency toward the *pedata* type, which must be the extreme of development in this direction.

If this form is regarded as separable from the preceding it must bear DeCandolle's name *leariloba*, which has priority over Prof. Greene's *inornata*. Both are based upon the same plate of Curtis' *Botanical Magazine*.

22. Viola fimbriatula Smith. (Pl. XXXVII, figs. i–iii; Pl. XXXVIII, fig. v.)

Viola primulæfolia Pursh, 1814, Flora Am. Sept., I, p. 173 (*nec* Linn.).
Viola fimbriatula Smith, 1817, Rees' Cyclop., XXXVIII.
Viola ovata Nuttall, 1818, Gen., I, p. 148.
Viola ovata belvisiana D. C., 1824, Prodr., I, p. 294.
Viola sagittata hicksii Pollard, 1895, Bot. Gazette, XX, p. 326.

Range.—From the lower mountains to the coast, through eastern Pennsylvania and central and southern New Jersey (not plentiful in the pine barrens).

Habitat.—Dry sandy or rocky banks and fields.

Description.—Flowering plant, Media, Delaware county, Pennsylvania, April 26, 1903. No. 5,145, Herb., W. S. Flowers 10–15 mm. broad, purple (between "aster-purple" and "violet" of Ridgway); petals white at the base, the lower one lined with darker; lateral petals with conspicuous patch of beard, lower one slightly pubescent; sepals lanceolate; scape pubescent, 30 mm. long. Leaves ovate-cordate, obscurely crenate, except at base, where teeth are more conspicuous, 15 x 20–18 x 30; thick and very pubescent, especially above; decurrent on the petiole, which is also densely pubescent, 12–18 mm. long.

Later flowering specimens have leaves 28 x 45 mm., petioles 35 mm. and scapes 60 mm. in length.

Fruiting plant, Media, June 4, 1903. No. 5,146, Herb., W. S. Pubescent all over; scapes 70 mm.; leaves 45 x 75 mm.; petioles 45–60 mm.; cleistogenes erect, 45 mm. high.

In some very dry exposed spots this species becomes quite stunted, but flowers profusely. A root from Gladwyn, April 26, has leaves only 7 x 12 mm., petioles 5 mm., but bears seven flowers on scapes 35 mm.

in length. The leaves are always very numerous, and owing to the short petioles—usually less than the blade—they appear very much crowded. Sometimes the teeth at the base are scarcely larger than the other crenations, while in other specimens two or three of them are quite prominent, showing an approach to *V. sagittata*.

The above descriptions apply to typical *V. fimbriatula*, but the plant is exceedingly variable and notwithstanding the fact that in their typical forms the present species and *V. sagittata* are abundantly distinct, there occur forms which are about as nearly intermediate as they can well be, so that the old practice of making one a subspecies of the other is by no means as absurd as Mr. Pollard would have us believe (*Proc. Biol. Soc. Wash.*, X, p. 89). One form which occurs abundantly near Christiana, Lancaster county (Pl. XXXVII, fig. ii), has leaves truly sagittate, 20 x 70 mm., with petioles more than twice as long. The whole plant is strongly pubescent, and the early leaves ovate. Prof. Greene identifies it as "uncommonly long-leaved *fimbriatula*." The step from this to the pubescent *sagittata* described beyond is surely very short. It is possible that there may be a separable intermediate form, but the question will bear more study before the true status of these intermediates is determined. In another direction *V. fimbriatula* approaches the leaf-form of *V. papilionacea*, and this form which is quite sharply defined has been named by Prof. Greene *V. aberrans*.

23. Viola fimbriatula aberrans (Greene). (Pl. XXXVII, figs. iv–vi.)
Viola aberrans Greene MSS.

Range.—Apparently coincides with that of the former.

Habitat.—Dry sandy and rocky banks, usually with *V. fimbriatula*, but less abundant, and always easily distinct.

Description.—This is essentially a long petioled *V. fimbriatula*, with broad, cordate, somewhat cucullate leaves, without strong basal teeth and usually somewhat less pubescent.

Flowering plant, Media, Pennsylvania, April 26, 1903. No. 5,147, Herb., W. S. Similar to preceding, but leaves 18 x 30 mm.; petioles 60 mm.; scapes 100 mm.

Fruiting plant, Media, June 4. No. 5,148, Herb., W. S. Leaves 75 x 100 mm.; petioles 210 mm.; cleistogenes horizontal, 30 mm. long.

This is a very well-marked form, though not common in the immediate vicinity of Philadelphia. Mr. Pollard's *V. porteriana* does not seem to occur in this vicinity at all, so that I have been unable to study it. I should, however, have very grave doubts about referring it to *V. dentata* of Pursh, which grows "in wet meadows and woods"! I fail to see the advantage of trying to utilize old names which are

coupled with such conflicting statements as this. I am aware that some forms of the *fimbriatula* group with nearly or entirely glabrous foliage occur in the New Jersey coast districts, but have not as yet had opportunities for studying them.

24. Viola sagitatta Ait. (Pl. XXXVI, figs. i–iii; Pl. XXXVIII, fig. i.)

Viola sagittata Aiton, 1789, Hort. Kewensis, III, p. 287.

Range.—Southeastern Pennsylvania, central and northern New Jersey, southward through the Delaware valley.

Habitat.—Moist meadows (forms occur also in dry ground).

Description.—Flowering plant, Tinicum, Delaware county, Pennsylvania, April 25, 1903. No. 5,133, Herb., W. S. Flower 15–18 mm. broad, dark purple ("violet" of Ridgway); all petals strongly veined with a darker shade, bases white, sometimes running out on upper petals to form a white spot at the point where they are reflexed; beard on laterals in a large basal patch, from which a scattered pubescence extends on to the purple area; base of lower and often exposed part of upper petals pubescent; upper petals usually large, rounded and nearly flat, and sometimes emarginate. Sepals linear-lanceolate, acute; scape glabrous, 50 mm. long. Leaves somewhat variable, the earliest nearly triangular, the others ovate-oblong or sagittate, generally rounded at the apex, crenate, with two or three prominent teeth at the base, glabrous, 8 x 12–12 x 25 mm.; petioles 15–45 mm., glabrous.

Later specimens, Tinicum, May 9, 1903, nearly out of bloom. Foliage quite glabrous throughout, leaves 12 x 45, sagittate, acute; petioles 90–110 mm.; scapes 100–140.

Fruiting plants, Tinicum, May 23, 1903. No. 5,135, Herb., W. S. Leaves strongly auriculate-toothed at base, 80 x 20 mm., 40 mm. across base, petioles 150 mm. Cleistogenes erect on peduncles 150 mm. tall. Specimens from near Haddonfield, New Jersey, June 27, 1903, No. 5,138, Herb., W. S., have leaves 100 mm. long and 60 mm. across the base; petioles 220 mm. These plants are somewhat pubescent, notably on the margins of the leaves, and present some forms perplexingly like *emarginata* (Pl. XXXVI, fig. iv). Others, to all appearances *sagittata* in leaf, form, etc., from dry sandy hillisdes near Newtown Square, Pennsylvania, are quite pubescent on both blades and petioles as well as on the scapes. These require further study.

25. Viola emarginata Nutt. (Pl. XXXVI, figs. iv–v; Pl. XXXVIII, fig. ii.)

Viola emarginata Nuttall, 1818, Genera, I, p. 147.

Range.—Southeastern Pennsylvania and southern New Jersey

mainly east of the pine barrens, but quite across the Cape May peninsula.

Habitat.—Low sandy ground or sandy woodland.

Description.—Flowering plants, Tinicum, Delaware county, Pennsylvania, April 25, 1903. No. 5,141, Herb., W. S. Flowers 15 mm. wide, blue, close to the color of the double cultivated species (between 'campanula blue" and "mauve" of Ridgway), base white, lower and laterals with dark lines, beard spreading from the basal spots on o the blue area, lower petal and upper ones as well pubescent with scattered hairs; petals all rather broad and rounded, lower one almost cup-shaped and truncate, all distinctly emarginate; sepals lanceolate-acute; scapes 60–80 mm. Leaves thick, fleshy and glabrous, nearly triangular, crenate, with basal teeth slightly more prominent, decurrent, .5 x 25 mm.; petiole glabrous, 40 mm. Later specimens, May 9, have erect cleistogenes on peduncles 75 mm. high.

Fruiting plants, Tinicum, June 21, 1903. No. 5,143, Herb., W. S. Leaves 50 x 5 mm., strictly triangular, margin dentate-crenate, coarser toward the base, petioles 200 mm., peduncles of cleistogenes 120 mm. high.

This seems to be the typical *V. emarginata.* Other colonies in Cape May county, New Jersey, have the summer leaves very broad across the base, with the teeth enlarged into deep lobes (Pl. XXXVI). Still others in Chester county, Pennsylvania, in woodland, develop eaves 90 x 90 mm., much expanded and lobed at base; petioles 300 mm. long! I have not had the opportunity of studying either of these ast in flower, so cannot state whether their blossoms conform in color to the Tinicum plants. The leaves of the Chester county specimens, while still thick and fleshy, are slightly but minutely pubescent.

The above descriptions will give some idea of the immense variability of the *sagittata* group, comprising numbers 22–25. *V. fimbriatula* seems to be the nearest to the supposed parent or *papilionacea* type. From it we pass to *sagittata,* of which *emarginata* seems to be an extreme development, with apparently a marked deviation in floral characters. The resemblance in leaf-form between *emarginata* and some aberrant *brittoniana* has already been commented upon. Whether the apparent intergrades which serve to confuse the *sagittata* group are really such, or the extremes of a somewhat variable species, is a difficult matter to determine.

II. Caulescent Species.

I.—Flowers yellow.
  a.—Plants strongly pubescent, ... V. pubescens.
  aa.—Plants nearly glabrous, ... V. scabriuscula.
II.—Flowers lilac-purple, ... V. muhlenbergii.
III.—Flowers white or cream-colored, ... V. striata.
IV.—Flowers white tinged with yellow and blue, stipules very large and laciniate, leaves small, mostly lanceolate, V. rafinesquii.

The caulescent violets in the vicinity of Philadelphia are much less variable than the acaulescent forms, and the species are much more sharply defined.

The yellow-flowered group is the most generally distributed.

26. Viola pubescens Ait.

Viola pubescens Aiton, 1789, Hort. Kewensis, III, p. 290.
Viola pensylvanica Michaux, 1803, Flor. Bor. Am., II, p. 149.
Viola pubescens eriocarpon Nuttall, 1818, Genera N. A., Pl. I, p. 150.

Range.—Southeastern Pennsylvania northward to Pike and Monroe counties (Porter), but apparently not on the higher Alleghanies; in New Jersey throughout the northern counties south to Monmouth (Britton).

Habitat.—Dry woodland.

Description.—Flowering plant, Elwyn, Delaware county, Pennsylvania, April 27, 1902. No. 2,583, Herb., W. S. Stem strongly pubescent, almost villous; stipules ovate, acuminate, nearly glabrous, except on the margin; leaves strongly pubescent above and below, reniform, cucullate, dentate, 40 x 55 mm.; petioles pubescent, 20–35 mm. Flowers yellow, the lower and lateral petals lined with very dark purple, a small spot of pubescence near the base of the laterals, 15–18 mm. broad; sepals linear-lanceolate; pedicels pubescent, 30–45 mm. long. These plants are about 150 mm. high; about two-thirds up a large leaf branches off dichotomously with the upper part of the stem, usually with a long pediceled axillary flower; the upper part of the stem bears several partly grown leaves and one or two short-stalked flowers; there are no radical leaves. Sometimes two stems rise from the same root, and one is often shorter than the other, bearing only one flower and two leaves.

Later fruiting plants are 300 mm. high, with four reniform or nearly triangular leaves, successively smaller, and two or three axillary seed-pods on successively shorter pedicels; pod 12 mm. long, sometimes glabrous and sometimes pubescent; the stem is now nearly erect, making the first leaf entirely lateral. There are often one or two reniform radical leaves on petioles 160 mm. long.

A specimen from Willow Grove, Montgomery county, Pennsylvania, July 16, 1902, No. 3,319, Herb., W. S., has developed branches at the summits of the fruiting pedicels, which have produced one or two smaller pods, apparently from cleistogamic flowers, and several small leaves, those on the lowest pedicel being orbicular, 20 mm. in diameter.

It seems certain that Nuttall's var. *eriocarpon* from Philadelphia is nothing more than an individual variation of this species. The pubescence of the pods is variable and not corollated with any other characters.

87. Viola scabriuscula Schw.

Viola scabriuscula Schweinitz, 1822, Am. Jour. Sci., V, p. 75.

Range.—Southeastern Pennsylvania to the highest mountains of Wyoming county, also northern New Jersey south to Trenton (Britton).

Habitat.—Damp woods along streams.

Description.—Flowering plant, Crum creek, Delaware county, Pennsylvania, April 10, 1903, No. 5,162, Herb., W. S. Stem glabrous or nearly so, often recumbent; leaves nearly glabrous, but with pubescence on the veins below, finely dentate-crenate, reniform, 20 x 30 mm.; stipules similar to *pubescens;* petiole (of first leaf) 30 mm., glabrous. Flower yellow, closely resembling the preceding species; pedicel glabrous, 20 mm. long. Plants 90 mm. in height. The first leaf and its flower clearly overtop the rest of the upper stem in this species at this stage, and the flower of the latter seems to be frequently cleistogamic. In *pubescens* the two flowers are about on a level and both flower at once. There are always two or three radical, reniform, glabrous leaves on pedicels 30 mm. long, and often several stems from one root.

Fruiting plants, Crum creek, May 17, 1903. No. 5,164, Herb., W. S. Plants 350 mm. tall, bearing three nearly triangular or slightly reniform leaves, coarsely dentate, crenate, 50 x 60 mm., with usually one seed-pod and a cleistogamic flower. Pods 10 mm. long, white, woolly or glabrous on contiguous plants. There are usually several smaller radical leaves. The pubescence of the pods seems to be purely an individual character, and is more variable than in *V. pubescens*.

Viola hastata occurs on the southern Alleghanies of Pennsylvania, north to Blair county, but not eastward.

88. Viola striata Ait.

Viola striata Aiton, 1789, Hortus Kewensis, III, p. 290.
Viola ochroleuca Schweinitz, 1822, Am. Jour. Sci., V, p. 69.

Range.—Southeastern Pennsylvania, in the river valleys. Very plentiful in the lower Susquehanna, also on the Brandywine at Chadd's Ford. Near Philadelphia it occurs only at Bartram's Garden, where

it is supposed to be native. In New Jersey, south to Trenton (Britton).

Habitat.—Low ground along streams.

Description.—Flowering plants, Bartram's Garden, Philadelphia, May 13, 1901. No. 1,083, Herb., W. S. Stem glabrous, several from one root, 150 mm. high; stipules large laciniate, leaves cordate-ovate, crenate, 30 x 35 mm., glabrous; petioles 20 mm. long, numerous smaller glabrous radical leaves. Flowers creamy-white, 15–20 mm. broad, lower and lateral petals lined with purplish-black, the former well bearded near the base; stipules linear-lanceolate; pedicels 50–60 mm. long.

Fruiting plants are 300 mm. high, with leaves 40 x 40 mm., quite acutely pointed. Some plants produce cleistogamic flowers in the upper axils.

29. Viola muhlenbergii Torrey.

Viola canina various American authors (*nec* European authors).
Viola uliginosa Muhlenberg, 1813, Catalogue, p. 26 (*nec* Schrader).
Viola muhlenbergii Torrey, 1824, Flora U. S., p. 256.
Viola muhlenbergiana ("Gingins" D. C., 1824, Prodromus, I, p. 297.

Range.—From the highest Alleghanies to Philadelphia; in New Jersey, northern counties south to Freehold, and casually in the lower Delaware valley to Salem (Britton).

Habitat.—Damp woodland, or sometimes open ground.

Description.—Flowering plant, Crum creek, Delaware county, Pennsylvania, April 10, 1903. No. 5,165, Herb., W. S. Stems glabrous, somewhat reclining, 70 mm. long, a number from the same root and with numerous radical leaves; stipules with lacunate margins. Leaves reniform or nearly orbicular, crenate, 15 x 15 mm., lower cauline 18 mm. in length. Flowers pale lilac-purple, lower petals lined with black, laterals slightly bearded; sepals linear-lanceolate. The lowest flower is very long-pediceled (50 mm.) and overtops the rest of the plant; there is usually one other true flower and often cleistogenes in the upper axils.

Fruiting plant, Crum creek, May 17, 1903. No. 5,166, Herb., W. S. Stems 200 mm. high, leaves 30 x 30 mm. Usually two or three fruiting pedicels and a cleistogene on each stem, each shorter than the one below; radical leaves still persistent.

While this is evidently closely allied to *V. labradorica* Schrank., the fact that Prof. Greene has shown that there are several distinct forms of this species in the northeastern part of the country makes it desirable to retain the present name for our plant. It is almost certainly distinct from the Labrador form, but probably may be regarded as a subspecies of it.

Viola rostrata Pursh is common in the Alleghanies and comes southward to Bucks county. Muhlenberg's name is unrecognizable until clearly defined by Pursh; his specimens, however, show that both writers had the same plant in view.

Viola canadensis Linn. is also abundant in our mountains, and there is a specimen in the Academy herbarium marked Sellersville, Bucks county, the farthest south that I have heard of its occurrence.

30. Viola rafinesquii Greene.

"*Viola bicolor*" and "*arvensis*" of several American authors (*nec* European authors).
Viola tenella Muhlenberg, 1813, Catalogue, p. 26 (*nec* Poiret, 1810).
Viola rafinesquii Greene, 1899, Pittonia, IV, p. 9.

Range.—Along the Susquehanna and Delaware rivers, and abundant at various localities in southern New Jersey outside the pine barrens.

Habitat.—Low sandy ground.

Description.—Flowering plants, Nottingham, Chester county, Pennsylvania, near Octoraro creek, May 6, 1902. Benjamin H. Smith. No. 5,171, Herb., W. S. Stems glabrous, 100–150 mm. high, often branching close to the base; stipules conspicuous, deeply cut, lobed; leaves 20 mm., linear-lanceolate or spatulate, the lower nearly orbicular (10 x 10 mm.), contracted into margined petioles, 8–10 mm. in length, obscurely toothed, glabrous. Flowers several in the upper axils on pedicels 25 mm. long, yellowish with a blue tinge, lower petal lined with black, 15–18 mm. wide, sepals rather broadly lanceolate-acute.

Plants in full fruit May 30, same size as above. No further growth takes place, and the plants soon wither up.

Nomenclature and Synonymy.

Difficult as it is to determine the number of distinct forms that exist among our violets, it is a still harder problem to ascertain what names they should be known by. Some 160 specific or varietal names have been proposed for violets of eastern North America, and as many of these are very meagrely described, it is well-nigh impossible to be sure what forms the authors had in hand.

In the preceding pages I have entered in the synonymy only such names as seem without reasonable doubt to refer to the species in question, and have discussed matters of nomenclature only so far as absolutely essential to the determination of the proper name to use in each case. In order, however, to satisfactorily cover the synonymy of the genus, I have prepared a list of the names known to me which have been applied to eastern North American violets—both specific and

subspecific—with some comment upon their status, the type locality and the group to which the name belongs, viz., "A.B." = Acaulescent blue; "C.Y." = Caulescent yellow, etc.

Many species recently described by Prof. Greene and Mr. Pollard are listed here which do not occur in the region that I have studied, and I am quite unprepared to discuss their relationship. In order, however, that some idea of their affinities may be obtained, I have given the names of the better known species with which they are compared in the original descriptions.

I have likewise noted in brackets the reference to the *Illustrated Flora* of Britton and Brown for all species recognized in that work. Additional species recognized in Britton's *Manual* have references to that work, and still others which are recognized in the preceding pages are marked accordingly.

The principal works and papers in which North American species are described or in which the genus is reviewed are:

LINNÆUS, 1753. Species Plantarum.
WALTER, 1788. Flora Carolina.
AITON, 1789, in Hortus Kewensis.
MICHAUX, 1803. Flora Boreali-Americana.
WILLDENOW, 1806. Hortus Beroliensis.
MUHLENBERG, 1813. Catalogue.
PURSH, 1814. Flora Americana Septentrionale.
SMITH, 1817, in Rees' Cyclopædia.
ELLIOT, 1817. Botany of South Carolina and Georgia.
NUTTALL, 1818. Genera of N. A. Plants.
SCHWEINITZ, 1822, in American Journal of Science, V.
DECANDOLLE, 1824. Prodromus, I.
LE CONTE, 1828. Annals Lyceum N. Y., II.
DON, 1831. General System.
GRAY, 1886. Botanical Gazette, XI, pp. 253–256 and 289–293.
POLLARD, 1896. Proc. Biological Soc. Wash., X, pp. 85–92.
POLLARD, 1898. Botanical Gazette, XXVI, pp. 325–342.
POLLARD, 1901, in Britton's Manual.
GREENE, 1896–1903. Various articles in Pittonia.

acuta "Bigelow" Torrey. 1824. Flora U. S., I, p. 253.
(A.W.) Proposed as a variety of and allied to *lanceolata*, if not identical. Cambridge, Mass.

affinis Le Conte. 1828. Ann. Lyc. N. Y., II, p. 138. [Britt. Manual, No. 9.]
(A.B.)

alabamensis Pollard. 1900. Proc. Biol. Soc. Wash., p. 169.
(A.B.) Allied to *villosa* and *carolina*.

alba Thurber?
(A.B.) A mere white form of *pedata*, of which it is styled a variety.
albiflora Don. 1831. Gen. Syst., I, p. 320.
(A.B.) A mere white form of *septemloba* Le Conte.
albiflora Don. 1831. Gen. Syst., I, p. 321.
(A.B.) A similar variant of "*heterophylla* Muhl." Other albinos have also been so named.
alleghaniensis Roem and Schult. Syst., 5, p. 560.
( ) Quoted by DeCandolle. I have been unable to verify it.
alsophila Greene. 1899. Pittonia, IV, p. 7.
(A.W.) New name for *amœna* Le C. See *leconteana* Don.
amœna Le Conte. 1828. Ann. Lyc. N. Y., II, p. 144.
(A.W.) Antedated by *amœna* Symons, 1798, Syn. Pl. Brit., p. 198. See *leconteana*.
amorphophylla Pollard. 1900. Proc. Biol. Soc. Wash., p. 129.
(A.B.) Related to *sagittata*. Tryon, N. Carolina.
angellæ Pollard. 1902. Torreya, II, No. 2, p. 24. [*antea*, p. 678.]
(A.B.) Orange, New Jersey.
arenaria D. C. 1805. Flor. France, IV, p. 806. [Ill. Flor., 2,508.]
(C.B.) A European species credited to North America.
arvensis.
(C.B.) A European species found also in North America.
asarifolia Muhlenberg. 1813. Cat., p. 26.
(C.B.) Not recognizable [specimens = *muhlenbergii*].
asarifolia Pursh. 1814. Flor. Amer. Sept. Suppl., p. 732.
(A.B.) Antedated by *asarifolia* Muhl., 1813. Virginia to Carolina.
atlantica Britton. 1897. Bull. Torrey Bot. Club., XXIV, p. 92.
(A.B.) Antedated by *atlantica* Pomel, 1874. See *brittoniana* Pollard. East Massachusetts to south New Jersey.
atropurpurea "Raf." D.C. 1824. Prodr., I, p. 291.
(A.B.) Proposed as a variety of *pedata*, and a pure synonym of true *pedata*.
attenuata "Sweet" Don. 1831. Gen. Syst., I, p. 322.
(A.W.) Proposed for *lanceolata* Pursh, which he regards as different from *lanceolata* Linn. The name does not occur in Sweet Hort. Brit., 1826, p. 37, to which reference is made.
australis Pollard. 1898. Bot. Gazette, XXVI, p. 342.
(A.W.) Proposed as a race of *primulæfolia*. Duval county, Florida.
barbata Muhlenberg. 1813. Cat., p. 26.
(A.B.) Unrecognizable.
barbata "Willd." D. C. 1824. Prodr., I, p. 292.
(A.B.) *Nomen nudum* in synonymy under *papilionacea*.
belvisiana D. C. 1824. Prodr., I, p. 294.
(A.B.) As a race of *ovata* "*in mont. editioribus Virginiæ*."
bernardi Greene. 1898. Pittonia, III, p. 260. [Britt. Manual, No. 4.]
(A.B.) As a race of *pedatifida*, southern Wisconsin.

bicolor Pursh. 1814. Flor. Amer. Sept., I, p. 175.
(C.W. or B.) Antedated by *bicolor* Hoffman. Fl. Germ., II. p. 170, which Pursh probably intended to quote.
bicolor "Pursh," Raf., D. C. 1824. Prodr., I, p. 291.
(A.B.) As synonym under *pedata atropurpurea* Raf. *nomen nudum.*
blanda Willdenow. 1806. Hort. Berolien, Pl. XXIV. [Ill. Flor., 2,497.]
(A.W.)
boscii D. C. 1824. Prodr., I, p. 293.
(A.W.) As a race of *primulæfolia*, and apparently identical with it. Carolina.
brainerdii Greene. 1902. Pittonia, V, p. 89.
(A.W.) = "Specimens No. 17, Distribution N. A. Violets." Vermont.
brittoniana Pollard. 1898. Bot. Gazette, XXVI, p. 332. [Ill. Flor., 2,485.]
(A.B.) New name for *atlantica* Britton.
canadensis Linn. 1753. Sp. Plant., pl. 936. [Ill. Flor., 2,505.]
(C. W.) Canada.
canina.
(C.B.) A European species credited to North America.
cardminefolia Greene, 1901. Pittonia, IV, p. 289.
(C.B.) Allied to *muhlenbergii*. Aylmer, Quebec.
carolina Greene. 1898. Pittonia, III, p. 259.
(A.B.) Allied to *fimbriatula*. Wilmington, North Carolina.
ciliata Muhlenberg. 1813. Cat., 26.
(A.B.) Not recognizable [his specimens = *villosa*].
clandestina Pursh. 1814. Flor. Amer. Sept., I, p. 173.
(A.Y.) Apparently = *rotundifolia*.
communis Pollard. 1898. Bot. Gazette, XXVI, p. 336.
(A.B.) New name for "*obliqua*" and "*cucullata*" of many recent authors, which are not this form, but not *communis* Wittrock; cf. Greene, Pittonia, IV, p. 140. Apparently = *papilionacea* Pursh.
congener Le Conte. 1828. Ann. Lyc. N. Y., II, p. 140.
(A.B.) = Form of *palmata* (cf. Greene, Pittonia, III, p. 142).
conjugens Greene, 1899. Pittonia, IV, p. 3. [Britton's Manual, No. 21.]
(A.B.) Allied to *emarginata* and *cucullata*. Anne Arundel county, Maryland.
consors Greene. 1902. Pittonia, V, p. 100.
(A.B.) Close to *cucullata*. Prince Edward's Island.
cordata Walter. 1788. Flor. Carol., p. 219.
(A.B.) Not recognizable.
cordata D.C. 1824. Prodr., I, p. 293.
(A.W.) As a race of *primulæfolia*.
cordifolia Nuttall. 1818. Gen., I, p. 148. [*antea*, p. 674.]
(A.B.) = Race of *villosa* Walter. Philadelphia.

cordiformis D. C. 1824. Prodr., I, p. 292.
(A.B.) As a race of *cucullata*. Not distinguishable.
crassula Greene. 1902. Pittonia, V, p. 96.
(A.B.) Allied to *crenulata:* Jackson, Michigan.
crenulata Greene. 1901. Pittonia, IV, p. 295. [*antea*, p. 674.]
(A.B.) Syracuse, New York.
cucullata Aiton. 1789. Hort. Kew., III, p. 288. [Ill. Flor., 2,487*b*.]
(A.B.) N. A. (from Dr. Samuel Martin).
cuspidata Greene, 1898. Pittonia, III, p. 314. [Britt. Manual, No. 8.]
(A.B.) Allied to *papilionacea*. Wisconsin.
debilis Michaux. 1803. Flor. Bor. Amer., II, p. 150.
(C.B.) Probably = *striata*. "In mont. Alleghanis."
dentata Pursh. 1814. Fl. Am. Sept., I, p. 172.
(A.B.) *sagittata* group, identity doubtful. Pennsylvania.
denticulosa Pollard. 1901. Bull. Torrey Bot. Club, XXVIII, p. 475.
(A.W.) Allied to *lanceolata*. Douglas, Coffee county, Georgia.
dicksonii Greene. 1899. Pittonia, IV, p. 65.
(A.B.) Allied to *cuspidata*. Canadian woods.
digitata Pursh. 1814. Fl. Amer. Sept., I, p. 171.
(A.B.) *palmata* group, identity doubtful. Virginia.
digitata Darlington. 1826. Florula Cestrica, p. 29.
(A.B.) Apparently intended for *digitata* Pursh. West Chester, Pennsylvania.
dilatata Elliott. 1817. Bot. S. C. and Ga., I, p. 300. [Britt. Manual, 1*a*.]
(A.B.) As a race of *palmata*. Upper districts Georgia and Carolina.
domestica Bicknell. 1898. In Britt. and Brown, Ill. Flora, III, p. 519.
(A.B.) Rich ground form of *papilionacea*. South Pennsylvania and New Jersey.
elegantula Greene. 1899. Pittonia, IV, p. 66.
(A.B.) "Foliage of *blanda*, flowers of *cucullata*." Ottawa, Canada.
emarginata Nuttall. 1818. Gen., I, p. 147. [Ill. Flor., app. 2,490*a*.]
(A.B.) Philadelphia and adjacent New Jersey.
eriocarpon Nuttall. 1818. Gen., I, p. 150.
(C.Y.) As a race of *pubescens*, from which it cannot be separated. Philadelphia.
esculenta Elliot. 1817. Bot. S. C. and Ga., I, p. 300.
(A.B.) Given as a synonym under "*heterophylla* Muhl.," which is fully described. Ogeechee river.
eurybiæfolia Greene. 1902. Pittonia, V, p. 25.
(C.W.) "Provisional" name for southern race of *V. canadensis* L., on the assumption that Linnæus had the northern form. Sullivan county, New York.
falcata Greene. 1899. Pittonia, IV, p. 3. [Britt. Manual, No. 6.]
(A.B.) *palmata* group. Cobden, Illinois.
fimbriatula Smith. 1817. Rees' Cyclop., XXXVIII. [= Ill. Flor., 2,491.]
(A.B.) A new name for *primulæfolia* Pursh (*nec* Linn.).

flabellifolia Loddiger. Botan. Cab., 777.
(A.B.) Quoted by Don, 1831. Apparently another name for *V. pedata bicolor* Pursh, though I have been unable to refer to it.
fletcheri Greene. 1901. Pittonia, IV, p. 296.
(A.B.) Allied to *papilionacea*. Ottawa, Ontario.
fragrans Elliot. 1817. Bot. of S. C. and Ga.
(A.B.) As a variety of *palmata*. Near Savannah, Georgia.
gibbosa "Raf." D. C. 1824. Prodr., I, p. 305.
(C.Y.) Possibly identical with *scabriuscula*. Alleghany Mountains.
glaberrima D. C. 1824. Prodr., I, p. 292.
(A.B.) Proposed as a variety of *cucullata* Ell., and intended as a new name for *cucullata* Ait., which is considered subspecifically different.
glaberrima Don. 1831. Gen. Synop., I, p. 329.
(C.Y.) As a variety of *hastata*, antedated by preceding.
hastata Michaux. 1803. Flor. Bor. Amer., II, p. 149. [Ill. Flor., 2,502.]
(C.Y.) High mountains of Carolina.
heterophylla Muhlenberg. 1813. Cat., p. 25.
(A.B.) Antedated by *heterophylla* Poiret and *heterophylla* Bertol.
hicksii Pollard. 1895. Botan. Gazette, XX, p. 326.
(A.B.) As a race of *sagittata*, and afterward referred to *ovata* as a subspecies. Rock Creek Park, District of Columbia.
hispidula D. C. 1824. Prodr., I, p. 292.
(A.B.) Proposed as a race of *cucullata*, not recognizable.
illinoiensis Greene. 1901. Pittonia, IV, p. 293.
(A.B.) Somewhat allied to *affinis*. Monticello, Illinois.
inornata Greene. 1896. Pittonia, III, p. 35.
(A,B.) New name for "*V. pedata* Curtis, Bot. Mag., t. 89," *nec pedata* Linn., which is the bicolored form. See *leariloba*.
insignis Pollard. 1898. Bot. Gazette, XXVI, p. 334.
(A.B.) Jacksonville, Florida. Name antedated by *insignis* Richter, 1888.
labradorica Schrank. 1818. Denksch. bot. Gesell. Regensb., II, p. 12.
(C.B.) I have not been able to consult this reference. The plant is probably distinct from *muhlenbergii*.
lætecœrulea Greene. 1901. Proc. Biol. Soc. Wash., p. 70.
(A.B.) Allied to *papilionacea*. Potomac Flats, District of Columbia.
lanceolata Linn. 1753. Sp. Plant., pl. 953. [Ill. Flor., 2,500.]
(A.W.) "Canada."
latiuscula Greene. 1902. Pittonia, V, p. 93.
(A.B.) Allied to *affinis*. Twin Mountain, West Rutland, Vermont.
leconteana Don. 1831. Gen. Syst., I, p. 324. [=Ill. Flor., var. *amœna*, under 2,497.]
(A.W.) New name for *amœna* Le Conte.

otosepala Greene. 1902. Pittonia, V, p. 98. [*antea*, p. 674.]
(A.B.) A race of *cucullata*. Oakland, Maryland.
visiana "Gingins" Don. 1824. Prodr., I, p. 298.
(C.W.) New name for *repens* Schw.
neariloba D. C. 1824. Prodr., I, p. 291. [*antea*, p. 681.]
(A.B.) Proposed as a variety of *pedata*, and based on Pl. 89 of Curtis Bot. Mag.
acounii Greene. 1898. Pittonia, III, p. 335.
(A.B.) "Very different from all other N. A. species." Ottawa and Quebec.
acrotis Greene. 1902. Pittonia, V, p. 97. [*antea*, p. 673.]
(A.B.) A race of *cucullata*. Surrallsville, Maryland, and Berlin, New Jersey.
elissæfolia Greene. 1903. Pittonia. V, p. 103.
(A.B.) "Allied to *nesiotica*." Prince Edward's Island.
istassinica Greene. 1899. Pittonia, IV, p. 5.
(A.W.) One of *blanda* group. Labrador.
uhlenbergii Torrey. 1824. Flor. U. S., I, p. 256. [Ill. Flor., 2,507.]
(C.B.) New name for *uliginosa* Muhl. (*nec* Schrader) and *debilis* Schw. (*nec* Michx.). Cedar swamp, New Durham, New Jersey.
uhlenbergiana "Gingins" D. C. 1824. Prodr., I, p. 297.
(C.B.) New name for *uliginosa* Muhl. (*nec* Schrader). Pennsylvania. Possibly antedates the preceding.
ulfordæ Pollard. 1902. Proc. Biol. Soc. Wash., p. 203.
(A.B.) Allied to *brittoniana*. Hempstead Plains, Long Island.
ulticaulis Torrey and Gray. 1838. Flora, I, p. 140. [Ill. Flor., 2,509.]
(C.B.) Allied to *muhlenbergii*.
ultifida Mill. 1768. Dict., 8 ed.
(A.B.) =*pedata* Linn., *vid* Greene, Pittonia, III, p. 35.
pctæfolia Greene. 1902. Pittonia, V, p. 93.
(A.B.) Allied to *affinis*. Some of No. 20 Dist. of N. A. violets are this. Washington, District of Columbia.
esiotica Greene, 1902. Pittonia, V, p. 102.
(A.B.) "Closely allied to *subviscosa*." Prince Edward's Island.
odosa Greene. 1901. Pittonia, IV, p. 296.
(A.B.) Related to *cuspidata*. Syracuse, New York.
uttallii Pursh. 1814. Flor. Amer. Sept., I, p. 174. [Ill. Flor., 2,501.]
(C.Y.) Missouri river.
uttallii Don. 1831. Gen. Syst., I, p. 324.
(A.B.) Proposed as a variety of *sororia*, and intended as a new name for *V. villosa cordifolia* Nutt., antedated by *nuttallii* Pursh, 1814.
bliqua Hill. 1769. Hort. Kew., p. 316, t. 12.
(A.B.) Not identifiable.
chroleuca Schweinitz. 1822. Amer. Jour. Sci., V, p. 69.
(C.W.) =*striata* Aiton. Dan river toward Saura Mountains.
dorata Linnæus. 1753. Sp. Plan., pl. 934. [Ill. Flor., 2,493.]
(A.B.) A European species introduced into North America.

ovata Nuttall. 1818. Gen., I, p. 148.
(A.B.) A new name for *primulæfolia* Pursh (*nec* Linn.). Philadelphia.
ovata "Raf." D. C. 1824. Prodr., I, p. 293.
(A.W.) Proposed as a race of *primulæfolia*. Pennsylvania.
pallens D. C. 1824. Prodr., I, p. 295.
(A.Y.?) Proposed as a race of *rotundifolia*, unrecognizable. Labrador.
palmata Linnæus. 1753. Sp. Plant., pl. 933. [Ill. Flor., 2,484.]
(A.B.) Virginia.
palustriformis Gray. 1886. Botan. Gazette, XI, p. 255.
(A.W.) Allied to *blanda*.
palustris Linnæus. 1753. Sp. Plant., pl. 934. [Ill. Flor., 2,495.]
(A.B.) A European species attributed to America.
papilionacea Pursh. 1814. Flor. Am. Sept., I, p. 173. [Ill. Flor., 2,487.]
(A.B.) Philadelphia.
pedata Linnæus. 1753. Sp. Plant., p. 933. [Ill. Flor., 2,492.]
(A.B.) Virginia.
pedatifida Don. 1831. Gen. Syst., I, p. 320. [Ill. Flor., 2,486.]
(A.B.) North America.
pensylvanica Michaux. 1803. Flor. Bor. Amer., II, p. 149.
(C.Y.) =*pubescens* Ait. Schuylkill river, Pennsylvania.
pensylvanica D. C. 1824. Prodr., I, p. 294.
(A.B.) As a race of *palustris*, unrecognizable.
populifolia Greene. 1898. Pittonia, III, p. 337.
(A.B.) Allied to *cuspidata*. Pt. Flamboro, Ontario.
porteriana Pollard. 1897. Bull. Torrey Bot. Club, XXIV, p. 404. [=Britt. Manual, No. 19.]
(A.B.) A member of the *sagittata* group. Bushkill Falls, Pennsylvania.
pratincola Greene. 1899. Pittonia, IV, p. 65. [Britt. Manual, No. 11.]
(A.B.) Allied to *papilionacea*. Windom, Minnesota.
primulæfolia Linn. 1753. Sp. Plant., pl. 934. [Ill. Flor., 2,499.]
(A.W.) Siberia and Virginia.
primulæfolia Pursh. 1814. Flor. Am. Sept., I, p. 173.
(A.B.) =*fimbriatula* Smith.
priosepala Greene. 1902. Pittonia, V, p. 99.
(A.B.) A race of *cucullata*. Vermont and Quebec.
puberula S. Watson. 1890. Gray's Manual (ed. VI), p. 81.
(C.B.) As a race of *muhlenbergii*. Lakes Huron and Superior.
pubescens Aiton. 1789. Hort. Kew., III, p. 290. [Ill. Flor., 2,503.]
(C.Y.) N. A. (from William Young).
punctata Schw. 1822. Am. Jour. Sci., V, p. 67.
(C.B.) Probably = *labradorica* Schrank. Labrador.
pygmæa "Donn" Muhlenberg. 1813. Cat., p. 26.
(A.W.?) Unrecognizable.
radicans D. C. 1824. Prodr., I, p. 297.
(C.W.) Possibly = *muhlenbergii* or *striata*. South Carolina.

rafinesquii Greene. 1899. Pittonia, IV, p. 9. [Ill. Flor., 2,512.]
(C.W. and B.) New name for *V. tenella* Muhl., which is a *nomen nudum*, and is antedated by *V. tenella* Poiret, 1810.
ranunculifolia "Gingins" D. C. 1824. Prodr., I, p. 291.
(A.B.) Proposed as a variety of *pedata*, but unrecognizable; reference is also made: "*ranunculifolia* Poir.! dict. 8, p. 626?".
renifolia Gray. 1870. Proc. Amer. Acad., VIII, p. 288. [Ill. Flor., 2,498.]
(A.W.) East Elba, New York.
repens Schweinitz. 1822. Amer. Jour. Sci., V, p. 70.
(C.W.) Allied to *striata*. Rocks of Saura Mountains.
rostrata Muhlenberg. 1813. Cat., p. 26. [Ill. Flor., 2,510.]
(C.B.) Unrecognizable, until described by Pursh, 1814, Flor. Am. Sept., I, p. 174. Easttown [=Easton], Pennsylvania.
rotundifolia Michaux. 1803. Flor. Bor. Amer., II, p. 150. [Ill. Flor., 2,494.]
(A.Y.) High Mountains, Carolina.
sagittata Aiton. 1789. Hort. Kew., III, p. 287. [Ill. Flor., 2,490.]
(A.B.) Pennsylvania (from Dr. John Fothergill).
sagittata Pursh. 1814. Flor. Am. Sept., I, p. 172.
(A.B.) Antedated by the above and probably = *fimbriatula*.
scabriuscula Schweinitz. 1822. Amer. Jour. Sci., V, p. 75. [Ill. Flor., 2,504.]
(C.Y.) Salem, North Carolina.
selkirkii "Pursh," Goldie. 1822. Edinb. Phil. Mag., VI, p. 324. [Ill. Flor., 2,496.]
(A.B.) Mountains about Montreal.
septemloba Le Conte. 1828. Ann. Lyc. N. Y., II, p. 141. [*antea*, p. 678.]
(A.B.) Pine woods, Carolina and Georgia.
septentrionalis Greene. 1898. Pittonia, III, p. 334. [Britt. Manual, 14.]
(A.B.) Allied to *cuspidata*. Ottawa.
sororia Willdenow. 1806. Hort. Berol., Pl. LXXII.
(A.B.) Application somewhat doubtful, probably = *dilatata*. North America.
striata Aiton. 1789. Hort. Kew., III, p. 290. [Ill. Flor., 2,506.]
(C.W.) N. A. (from William Young).
striata Schweinitz. 1822. Am. Jour. Sci., V, p. 76.
(C.Y.) Allied to *hastata*, but name antedated by the last.
striata Willis. 1874. Catalogue Plants of N. J.
(A.B.) As a race of *cucullata*, from which it does not seem separable.
subsagittata Greene. 1898. Pittonia, III, p. 315.
(A.B.) Allied to *sagittata*. West of Lake Michigan.
subsinuata Greene. 1898. Pittonia, III, p. 313.
(A.B.) As a race of *emarginata*. Mountains, East Tennessee.
subvestita Greene. 1897. Erythrea, VI, p. 39.

subviscosa Greene. 1901. Pittonia, IV, p. 293.
(A.B.) Allied to *septentrionalis*. Prince Edward's Island.
tenella Muhlenberg. 1813. Cat., p. 26.
(C.B. and W.) *Nomen nudum* and antedated by *tenella* Poiret, 1810, in Lam. dict., n. 53 = *rafinesquii*.
tenuipes Pollard. 1902. Proc. Biol. Soc. Wash., p. 201.
(C.Y.) Allied to *hastata*. Chattahoochee, Florida.
thompsonæ Chapman. 1897. Flor. So. States (Ed. III).
(A.B.) = *odorata* Linn.
tricolor Linnæus. 1753. Sp. Plant., pl. 935. [Ill. Flor., 2,511.]
(C.B.) A European species, introduced.
triloba Schweinitz. 1822. Am. Jour. Sci., V, p. 57.
(A.B.) Probably = *dilatata*.
tripartita Elliot. 1817. Bot. S. Car. and Ga., I, p. 302.
(C.Y.) A race of *hastata*. Athens, Georgia.
uliginosa Muhlenberg. 1813. Cat., p. 26.
(C.B.) As synonym under *asarifolia*, antedated by *uligin*[illegible] Schrad.
vagula Greene. 1899. Pittonia, IV, p. 67. [Britt. Manual, No. 1[illegible]
(A.B.) Allied to *venustula* and *cucullata*. Ottawa.
variabilis Greene. 1902. Pittonia, V, p. 91.
(A.B.) Harper's Ferry, Virginia.
variegata "Donn" Muhlenberg. 1813. Cat., p. 26.
(A.B.?) Unrecognizable.
velutina Schweinitz. 1822. Amer. Jour. Sci., V, p. .
So quoted by some authors, but not to be found in Schweinitz[illegible] paper.
venustula Greene. 1898. Pittonia, III, p. 335. [Britt. Manual, 1[illegible]
(A.B.) Allied to *cucullata*. Ottawa.
vicinalis Greene. 1899. Pittonia, IV, p. 9.
(A.B.) New name for *insignis* Pollard (*nec* Richter, 1888).
viarum Pollard. 1901. Britton's Manual, p. 635, No. 5.
(A.B.) Allied to *bernardi*. Valley Park, Missouri.
villosa Walter. 1788. Flor. Carol., p. 219. [Ill. Flor., 2,488.]
(A.B.) More fully described by Elliot, 1817. South Carolina.
vittata Greene. 1898. Pittonia, III, p. 258.
(A.W.) A southern ally of *lanceolata*. Florida.
vulgaris Elliot. 1817. Bot. S. Car. and Ga., I, p. 300.
(A.B.) As a variety of *palmata*.
watsoni Greene. 1899. Pittonia, IV, p. 5.
(A.W.) One of the *blanda* group. Prince Edward's Island.

Explanation of Plates XXXI–XXXIX.[1]

LATE XXXI, Fig. i.—*Viola villosa cordifolia.*—*a.* Three leaves from early flowering plants. *b.* Leaf from older plant. *c.* Two leaves from fruiting plants.
Fig. ii.—*Viola affinis.*—*a.* Three leaves from early flowering plants. *b.* Two older leaves. *c.* Two leaves from fruiting plants.

LATE XXXII, Fig. i.—*Viola papilionacea.*—*a.* Two early leaves. *b.* Two later leaves. *c.* Two leaves from fruiting plant.
Fig. ii.—*Viola cucullata.*—*a.* Two early leaves. *b.* Later leaf. *c.* Leaf from plant in fruit.
Fig. iii.—*Viola crenulata.*—*a.* Three leaves from flowering plant. *b.* Leaf from fruiting plant.

LATE XXXIII.—*Viola palmata dilatata.*—1–2. Early leaves. 3–7. Older leaves from flowering plants. 8–13. From fruiting plants.

LATE XXXIV, Fig. i.—*Viola palmata.*—*a.* Early leaf. *b.* Later leaf. *c.* From fruiting plant. *d.* Late summer leaf.
Fig. ii.—*Viola palmata angellæ.*—*a.* Early leaf. *b.* Three leaves from fruiting plant.

LATE XXXV, Fig. i.—*Viola brittoniana.*—*a.* Three early leaves. *b.* Two older leaves. *c.* Two leaves from fruiting plant.
Fig. ii.—*Viola septemloba.*—*a.* Three early leaves. *b.* Older leaf. *c.* Two leaves from plant in fruit.

LATE XXXVI, Fig. i.—*Viola sagittata,* Tinicum, Delaware county, Pennsylvania.—*a.* Three early leaves. *b.* Two later leaves. *c.* Three leaves from plants in fruit.
Fig. ii.—*Viola sagittata,* broader-leaved plant, Tinicum, Delaware county, Pennsylvania.—*a.* Early leaf. *b.* From fruiting plant.
Fig. iii.—*Viola sagittata* (approaching *emarginata*?), Haddonfield, New Jersey.—*a.* Early leaf. *b.* From fruiting plant.
Fig. iv.—*Viola emarginata.*—*a.* Three early leaves. *b.* Two leaves from fruiting plants.
Fig. v.—*Viola emarginata.*—Four leaves from late summer plants.

LATE XXXVII, Fig. i.—*Viola fimbriatula.*—*a.* Two early leaves. *b.* Three older leaves. *c.* Leaf from fruiting plant.
Fig. ii.—*Viola fimbriatula.*—From fruiting plant.
Fig. iii.—*Viola fimbriatula.*—Exceptionally long petioled slender leaf.
Fig. iv.—*Viola fimbriatula annectens.*—*a.* Early leaf *b.* Fruiting leaf.
Fig. v.—*Viola fimbriatula annectens.*—From fruiting plant.
Fig. vi.—*Viola fimbriatula annectens*?.—Early leaf.

LATE XXXVIII, Fig. i.—*Viola sagittata.*
Fig. ii.—*Viola emarginata.*
Fig. iii.—*Viola papilionacea.*
Fig. iv.—*Viola cucullata.*
Fig. v.—*Viola fimbriatula.*

LATE XXXIX, Fig. i.—*Viola palmata.*
Fig. ii.—*Viola brittoniana.*
Fig. iii.—*Viola septemloba.*
Figs. iv and v.—*Viola palmata dilatata.*

[1] The drawings represent leaves that have been pressed flat, and no attempt as been made to denote cucullation.

OCTOBER 20.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Twenty-three persons present.

Inclusions in Quartz.—MR. HUGO BILGRAM remarked that on examining a section of the "Blue Quartz" of Bucks county, Pennsylvania, he had observed some very interesting inclusions. This quartz contains small crystals of a bluish tint, exceedingly small needle-shaped crystals, some apparently opaque, and larger and smaller amorphous black masses distributed in irregular groups, mostly in sheets throughout the rock, probably consisting of graphite. There are also numerous small cavities filled with liquid, probably water, containing small bubbles. A few of these latter cavities were found to contain small, loose particles which, in connection with the enclosed bubbles, exhibit the phenomenon known as the Brownian movements. Some are prismatic crystals or fragments, others opaque particles of irregular shape. These inclusions clearly demonstrate that the Brownian movements continue indefinitely, the gneiss beds from which the blue quartz originates belonging to the oldest geologic formations.

Some of the cavities contain a number of such crystals. Owing to the constant movement it was difficult to count them with certainty, but he had counted no less than five or six particles in several cavities.

These inclusions of suspended particles seem to be very rare, as he had examined hundreds of splinters and had succeeded in finding only a few exhibiting these phenomena. They seemed to be grouped. If one cavity containing a loose crystal is found in a section, it is likely that more can be discoverd by a close examination. The first section in which he discovered them contains at least twenty such cavities. The dimensions of the particles are exceedingly small. One of the largest prismatic crystals found is about 6 micro-millimeters long and about $\frac{1}{3}$ micro-millimeter thick. Others are too small for even approximate measurement.

MR. FRANK J. KEELEY stated that he had succeeded in showing that these crystals have double-refractive qualities. By placing the section between two Nichol's prisms, so as to obtain a dark field, a careful observation will reveal that these crystals occasionally light up as their optic axis happens to become practically paralleled with the line of sight. They look very much like fireflies.

Messrs. Theodore Brooks, Allen J. Smith, Frederick L. Lewton, Thomas Barbour and Edward G. Vanatta were elected members.

The following were accepted for publication:

STUDIES IN OLD WORLD MANTIDÆ (ORTHOPTERA).

BY JAMES A. G. REHN.

The material forming the base of the present paper is almost entirely contained in the collections of the Academy of Natural Sciences of Philadelphia and the United States National Museum. The author is indebted to Dr. W. H. Ashmead of the latter institution, for the privilege of examining the material under his charge.

Subfamily **Orthoderinæ**.

Genus **EREMIAPHILA** Lefebvre.

1835. *Eremiaphila* Lefebvre, Ann. Soc. Entom. France, IV, p. 468.

Type.—By selection *E. luxor* Lefebvre.[1]

Eremiaphila bove Lefebvre.

1835. *Eremiaphila bove* Lefebvre, Ann. Soc. Ent. France, IV, p. 492. [Desert of Suez.]

Two immature specimens; Egypt.[2] (Dr. H. C. Wood.) [A. N. S. Phila.]

These appear to be the only specimens in existence except the types.

Eremiaphila sabulosa Saussure.

1871. *E[remiaphila] sabulosa* Saussure, Mélanges Orthoptérologiques, Suppl., III fasc., p. 387. [Isthmus of Suez.]

One immature specimen; Egypt. (Dr. H. C. Wood.) [A. N. S. Phila.]

This species has apparently not been recorded since the original description.

Genus **THEOPOMPA** Stål.

1877. *Theopompa* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, Band 4, No. 10, pp. 22, 47.

Included *ophthalmica* (Olivier) and *servillei* (Haan), of which the latter can be considered the type.

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[1] Of the originally included species (*audouin*, *cerisy*, *gene*, *zetterstedt*, *luxor*, *bove*, *savigny*, *khamsin*, *kralil*, *kheych*, *typhon*, *petit*, *hebraica* and *anubis*), *luxor* possesses the best figure, and for that reason I have selected it as the type.

[2] Dr. Wood has very kindly given me the following information regarding the specimens in the Academy's collection presented by him, and simply labelled "Egypt": My Egyptian collections were made in three places—at Helowan and at the Menai House in the desert, seven or eight miles from Cairo; at Assouan (at the First Cataract on the Nile); and probably some at Luxor on the Nile.

Theopompa servillei (Haan).

1842. *Mantis servillei* Haan, Verhand. Natuurl. Gesch. Neder. overz. bezitt., p. 81, tab. 16, figs. 5–6. [Lewibonger, Java, 300 feet elevation.]

One female; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

Genus **CHIROPUS** Saussure.

1869. *Chiropus* Saussure, Bull. Soc. Entom. Suisse, III, pp. 54, 61.

Type.—*Chiropus dives* Saussure.

Chiropus insidiator (Wood-Mason).

1882. *Tarachodes insidiator* Wood-Mason, Journ. Asiat. Soc. Bengal, LI, Pt. 2, p. 22. [Nyassa, East Africa.]

Two somewhat immature females; Zulu Mission, South Africa. [A. N. S. Phila.]

This species has been recorded from Barberton in the Transvaal, Nyassaland, Voi in British East Africa and Somaliland.

Genus **PYRGOMANTIS** Gerstaecker.

1869. *Pyrgomantis* Gerstaecker, Archiv für Naturgeschichte, XXXV, Band I, p. 210.

Type.—*P. singularis* Gerstaecker.

Pyrgomantis singularis Gerstaecker.

1869. *Pyrgomantis singularis* Gerstaecker, Archiv für Naturgeschichte, XXXV, Band I, p. 211. [Between Mombasa and Wanga, East Africa.]

Three immature males; Zulu Mission, South Africa. [A. N. S. Phila.]

This species has been recorded from Pretoria, Transvaal, Natal and Zululand.

Subfamily **Mantinæ**.

Genus **IRIDOPTERYX** Saussure.

1869. *Iridopteryx* Saussure, Bull. Soc. Ent. Suisse, III, pp. 55, 63.

Included species, *I. iridipennis* and *glauca*, the former being the type, as the latter was later removed to *Micromantis* by Saussure.

Iridopteryx infumata Saussure.

1872. *G[onypeta]* (*Iridopteryx*) *infumata* Saussure, Mélanges Orthoptérologiques, IV, p. 30. ["L'Egypte (suivant l'etiquette; mais pourrait être des Indes?)"]

Two specimens, male and female; Trong, Lower Siam; January–February, 1899. (Dr. W. L. Abbott.) [U. S. N. M.]

Genus **AMELES** Burmeister.

1838. *Ameles* Burmeister, Handb. d. Entom., II, p. 531.

Included *nana*, *minima*, *aurantiaca* and *flavicincta*. The first of

these was removed to *Parameles*, and of the remaining three *minima* may be selected as the type.

Ameles malaccana n. sp.

Type: ♀; Trong, Lower Siam. (Dr. W. L. Abbott.) [Cat. No. 6,955, U. S. N. M.]

This species is probably related to *A. abjecta* Cyrillo (=*spallanzania* Rossi et auct.) and *A. decolor* Charpentier of southern Europe. While quite distinct from either of these forms, no satisfactory comparison can be made without good figures or accurate descriptions, and as the existing ones are based chiefly on the males, no comparative diagnostic characters can be given. The central Asian *A. alata* Saussure is an entirely different insect, the female having wings as long as the body.

Size rather small; form rather robust, abdomen moderately expanded. Head very slightly broader than deep; vertex subtruncate, juxta-ocular lobes rounded; eyes ovate when viewed laterally; ocelli disposed in a small triangle; facial shield moderately transverse, the superior margin very slightly arcuate.] Pronotum over twice as long as broad; collar broad and gradually expanding into the rather well-marked, but evenly curved, supra-coxal expansion; shaft contracting posteriorly; surface with sparse tubercles, median carina slightly marked on the shaft, at the posterior margin flanked by a pair of moderate-sized blunt tubercles; margins, except the anterior and posterior, with rather even, short dentiform spines. Tegmina very short, not equal to the pronotum in length; apex obtuse, narrowly rounded. Wings very slightly exceeding the tegmina in length. Abdomen sub-fusiform, the apex rather strongly constricted, the whole bearing a distinct dorsal median carina. Supra-anal plate transverse, the apical margin subrotundate. Cerci not exceeding the subgenital plate in length, depressed. Subgenital plate large, apex rostrate, compressed. Anterior coxæ very slightly longer than the pronotum, the lower margin finely denticulate; femora slightly longer than the pronotum, very heavily built, external margin bearing five large spines, one of which is blunt and apical, internal margin bearing thirteen unequal spines, discoidal spines three in number; tibiæ very slightly more than half the length of the femora, the external margin bearing nine spines, the basal ones much smaller than the apical, the internal margin bearing eight spines, the basal ones smaller than the apical; metatarsi slightly exceeding the remaining tarsal joints in length. Median limbs slender, tibiæ shorter than the femora, the metatarsi not equal to the remaining tarsal joints in length.

General color dull umber, obscurely and irregularly spotted and

blotched with dull ochraceous. Anterior femora with the internal face shining black.

Measurements.

Total length,	20.5	mm.
Length of pronotum,	6	"
Greatest width of pronotum,	3.1	"
Length of tegmina,	4.5	"
Length of anterior femora,	7	"

Genus **STATILIA** Stål.

1877. *Statilia* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, Band 4, No. 10, pp. 36, 55.

Included *Pseudomantis nemoralis* and *Mantis apicalis* Saussure, of which the former may be selected as the type.[3]

Statilia maculata (Thunberg and Lundahl).

1784. *M[antis] maculata* Thunberg and Lundahl, Dissert. Entomolog., Pt. III, p. 61. [Japan.]

Thirty-eight specimens; fourteen males, twenty-four females:

Yokohama, Japan. (Loomis.) [A. N. Caudell.]

Kioto, Japan. (Y. Hirase, No. 29.) [A. N. S. Phila.]

Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

Goenong Soegi, Lampong, Sumatra. October–November, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.]

After a critical examination of the above rather extensive series, I agree with Bolivar[4] that *maculata* and *haani* are inseparable. The difference in size in the series examined is, I admit, rather startling, the extremes in total length being 39.5 and 61.5 mm., but intermediates between these form a completely connected series. The Kioto series alone contains the two extremes and a great number of intermediates. The coloration of the whole series is rather uniform, but several are dull blackish-brown instead of the usual grayish-brown.

Genus **TENODERA** Burmeister.

1838. *Tenodera* Burmeister, Handb. der Entom., II, p. 534.

Included *fasciata* Olivier (=*superstitiosa* Fabricius), *chloreudeta* (=*aridifolia* Stoll), and *tessellata* (=*australasiæ* Leach). Of these the first may be selected as the type.

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[3] The genus *Pseudomantis* Saussure (Bull. Soc. Ent. Suisse, III, pp. 56, 228) contained two species, *albofimbriata* Stål and *nemoralis* Saussure. As Stål removed *nemoralis* to *Statilia* and left *albofimbriata* in *Pseudomantis*, the latter can be regarded as the type of Saussure's genus.

[4] *Ann. Soc. Ent. France*, LXVI, pp. 309–310.

Tenodera superstitiosa (Fabricius).

1781. [*Mantis*] *superstitiosa* Fabricius, Species Insect., I, p. 348. [Æquinoctial Africa.]

One female; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

Genus PARATENODERA n. gen.

Type.—*Tenodera sinensis* (Saussure).

This genus can readily be separated from *Tenodera* s. s. by the stouter and heavier form, much less elongate pronotum, the broader head, the higher facial shield and the heavier anterior limbs. The principal differential characters would be as follows:

A.—Head with the facial shield about three times as broad as high; pronotum with the collar about one-fifth of the total length of the pronotum; anterior coxæ with the lower margin with very obsolete denticles, ... *Tenodera* Burm.

AA.—Head with the facial shield about twice as broad as high; pronotum with the collar not less than one-fourth of the total length of the pronotum; anterior coxæ with the lower margin strongly denticulate, ... *Paratenodera* Rehn.

Paratenodera aridifolia (Stoll).

1787. [*Mantis*] *Aridifolia* Stoll, Natuurlijke Afbeeldingen en Beschrijvingen, Spooken, pp. 65, 78, Pl. XXII, fig. 82. [East Indies.]

Ten specimens; one male, nine females:

Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

Goenong Soegi, Lampong, Sumatra. October–November, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.]

These specimens are quite constant in size, and in the series examined both the brown and green phase of coloration are present, and in about equal proportion.

Paratenodera sinensis (Saussure).

1871. *T*[*enodera*] *aridifolia* var. *sinensis* Saussure, Mélanges Orthoptérologiques, III, Suppl., p. 419. [Ningpo, China.]

Thirty-two specimens; twelve males, twenty females:

Kioto, Japan. (Y. Hirase, Nos. 32 and 33.) [A. N. S. Phila.]

Yokohama, Japan. (Loomis.) [A. N. Caudell.]

The above excellent series shows that the full brown phase of coloration is apparently rather scarce in *sinensis*, as it is present in but two out of thirty-two specimens. In a series of eighteen specimens of this species, taken from the introduced colony at Mt. Airy, Philadelphia, the proportion is two in eighteen. The variation in size is rather great,

the females in the series ranging from 25 to 30.5 mm. in the length of the pronotum.[5]

After a comparison of *sinensis* with *aridifolia* there can be no doubt but that they represent very distinct species.

Genus **POLYSPILOTA** Burmeister.

1838. *Polyspilota* Burmeister, Handb. der Entom., II, p. 534.

Included *conspersa*, *albimacula* (=*Mantis domingensis* Palisot), *varia* (=*pustulata* Stoll), *variegata* (=*striata* Stoll), and *catenata* (=*pustulata* Stoll). As only one, *albimacula*, has been removed from the genus, the type must be selected from the remaining four species. As probably the best known and most representative form of the genus is *striata* Stoll, *variegata*, which equals *striata*, may be selected as the type.

Polyspilota striata (Stoll).

1787. [*Mantis*] *Striata* Stoll, Natuurlijke Afbeeldingen en Beschrijvingen, Spooken, pp. 34, 78, Pl. XI, fig. 41. [Coast of Angola.]

Two females; Gaboon River, West Africa. (Rev. M. Nassau.) [A. N. S. Phila.]

While these specimens have been dried from alcohol, still it is evident that two color phases, a light and a dark type, are present in this species.

Genus **LEOMANTIS** n. gen.

Type.—*Leomantis ignota* n. sp.

Allied to *Sphodropoda* Stål,[6] but differing in the very much stouter form, the very much wider costal field of the tegmina, the strongly depressed head and peculiarly developed anterior femora.

Leomantis ignota n. sp.

Type: ♀; Zulu Mission, South Africa. [A. N. S. Phila.]

Size medium; form very stout and robust. Head strongly compressed, subocular in outline, though slightly longitudinal; vertex very narrowly rounded, arcuate when viewed from the front; eyes ovoid in outline; ocelli small, disposed in a triangle; facial shield over twice as wide as high, the superior margin very obtuse-angulate, the inferior truncate; antennæ not quite equal to the pronotum in length, filiform. Pronotum very stout, the greatest width equal to half the entire length; collar short, passing without any marked differentiation into the wide

[5] One female from the Mt. Airy colony exceeds any of the Japanese specimens in size, measuring as follows: Total length 104; length of pronotum 31.4; length of tegmina 64.5; length of anterior femora 24 mm.

[6] *Öfversigt K. Veten.-Akad. Förhandl.*, 28, No. 3, p. 399. Type, *Mantis tristis* Saussure.

supracoxal dilation, posterior two-thirds of the shaft subequal; dorsal surface finely tuberculate, a strong longitudinal sulcus present on the posterior half of the collar and the anterior half of the shaft; margins strongly denticulate except on the anterior portion of the collar; acetabular spine erect, robust. Tegmina short and rounded, not reaching the apex of the abdomen; costal margin strongly arcuate, sutural margin moderately so, apex obtuse-angulate; costal field at the widest point equal to one-half the width of the entire tegmina; stigma corneous, slender, subfusiform, longitudinal. Wings about equalling the tegmina in length when in repose. Abdomen strongly expanded. Supra-anal plate triangularly produced, the apex obtuse-angulate. Cerci attenuate, about equal to the subgenital plate in length. Subgenital plate produced, apex rostrate. Anterior coxæ slightly shorter than the pronotum, superior margin serrate, lower margin with elongate dentiform spines; femora equal to the pronotum in length, superior margin bearing a large, rounded, foliaceous expansion on the apical two-thirds of the joint, lower external margin bearing four large spines, two medium-sized apical spines, and a series of small blunt spinous tubercles between the largest spines, discoidal spines four in number, closely placed, internal margin anterior to the discoidal spines bearing a series of thirteen spines, posterior to the discoidal spines a series of five blunt tubercles; tarsi somewhat exceeding half the length of the femora, the superior margin bearing an arcuate foliaceous ridge, external margin bearing a series of seven spines, the basal portion unarmed, the internal margin bearing a series of fourteen spines; metatarsi stout, slightly longer than the remaining joints united. Median and posterior limbs rather robust; femora armed with genicular spines, the genicular lobes rounded; posterior metatarsi not two-fifths of the total tarsal length.

As the specimens examined are all from alcohol, and consequently with the natural colors destroyed, no color notes can be given.

Measurements.

Total length,	50.5 mm.
Length of pronotum,	17 "
Greatest width of pronotum,	8 "
Length of tegmina,	21 "
Greatest width of tegmina,	13 "
Length of anterior femora,	17 "
Greatest width of anterior femora,	6 "

Beside the type three immature specimens from the same locality have been examined.

Genus **SPHODROMANTIS** Stål.

1872. *Sphodromantis* Stål, Öfversigt K. Veten.-Akad. Förhandlingar, 28, No. 3, p. 390.

Included *bioculata* Burm., *lineola* Burm. and *gastrica* Stål, of which the latter may be selected as the type, Stål having had specimens of it before him when he founded the genus.

Sphodromantis bioculata (Burmeister).

1838. *M*[*antis*] *bioculata* Burmeister, Handb. der Entom, II, p. 537. [Egypt, Nubia and Syria.]

One male and one female: .

Egypt.[7] (Dr. H. C. Wood.) [A. N. S. Phila.]

Tunis, Africa. (W. P. Chandler.) [A. N. S. Phila.]

The remark made by Saussure and Zehntner[8] concerning the small size of Barbary coast specimens holds true regarding the specimen from Tunis.

Sphodromantis gastrica (Stål).

1859. *Mantis gastrica* Stål, Öfversigt K. Veten.-Akad. Förhandlingar, XV, (1858), p. 307. [Eikhams, South Africa.]
—1901. *Sphodromantis bioculata* Rehn (not of Burmeister), Proc. Acad. Nat. Sci. Phila., 1901, p. 284. [Sheikh Husein, Gallaland.]

Two females, one immature; Zulu Mission, South Africa. [A. N. S. Phila.]

A re-examination of the immature specimen recorded by the author as *bioculata* shows that it is undoubtedly Stål's *gastrica*.

Sphodromantis rudolfæ (Rehn).

1901. *Sphodropoda rudolfæ* Rehn, Proc. Acad. Nat. Sci. Phila., 1901, p. 282. [Near southern end of Lake Rudolf, western Gallaland.]

This species is a member of the genus *Sphodromantis*, and allied to *S. gastrica*, but the two species can readily be differentiated by the following key.

A.—Greatest width of the costal field of the tegmina median; tegmina surpassing the abdomen; pronotum rounded anteriorly. *gastrica* Stål.

AA.—Greatest width of the costal field of the tegmina basal; tegmina not equalling the abdomen; pronotum rather attenuatea nteriorly. *rudolfæ* Rehn.

Genus **HIERODULA** Burmeister.

1838. *Hierodula* Burmeister, Handb. d. Entom., II, p. 536.

Included *membranacea* Burmeister (=*birivia* Stoll), *hybrida* Burmeister, and *simulacrum* Fabricius. Of these the first may be selected as the type.

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[7] See p. 701, footnote.
[8] *Hist. Phys. Nat. et Polit. Madagasc.*, XXIII, Pt. I, p. 186.

Hierodula vitrea (Stoll).

1787. [*Mantis*] *Vitrea* Stoll, Natuurlijke Afbeeldingen en Beschrijvingen, Spooken, pp. 15, 77, Pl. V, fig. 19. ["Surinam."]

Two females; Batu Sangkar, Tanah Datar, Padangsche Bovenland, Sumatra. August–September, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.]

This species has been recorded from Siam to Celebes.

Hierodula patellifera (Serville).

1839. *Mantis patellifera* Serville, Orthoptéres, p. 185. [Java.]

Nine specimens; three males, six females; Kioto, Japan. (Y. Hirase, No. 35.) [A. N. S. Phila.]

These specimens agree with Serville's original description in having the two brown bars on the basal portion of the lower surface of the pronotum. On account of this character and the more numerous dentiform processes on the anterior coxæ, I have separated this species from *H. bipapilla* (Serville), with which it is usually synonymized. The pronotum and wings in the male also appear to be somewhat shorter than Saussure's measurements of *bipapilla*,[9] though the other proportions do not differ materially.

One specimen of the above-mentioned series is in the full brown phase, another partially so, and the remainder all in the green condition. The stigma in some specimens is surrounded by an irregular cloud of umber, while in others the cream-colored spot has no surrounding tint.

Hierodula gracilicollis Stål.

1877. *H[ierodula] gracilicollis* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, Bd. IV, No. 10, p. 58. [Sarawak.]

One male; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

This specimen does not entirely fit Stål's brief and unsatisfactory description which is based on the female. The tegmina and wings are, of course, very different in proportions and shape, but the other characters agree very well. The measurements of this specimen may prove of interest:

Total length (head and body),	66	mm.
Length of pronotum,	21.5	"
Greatest width of pronotum,	6.2	"
Posterior width of pronotum,	4	"
Length of tegmina,	47.5	"
Greatest width of tegmina,	12.2	"
Greatest width of costal field,	3.7	"
Length of anterior femora,	15.5	"

[9] *Mélanges Orthoptérologiques*, fasc., III, p. 227.

Genus **RHOMBODERA** Burmeister.

1838. *Rhombodera* Burmeister, Handb. d. Entom., II, p. 536.

Included *R. valida* and *R. laticollis* Burmeister.

Rhombodera scutata Karsch.

1892. *Rhombodera scutata* Karsch, Entomol. Nachrichten, XVIII, p. 6. [Angola and Malange, W. Africa.]

One female; three hundred miles inland from Benguella, Angola. (Misses M. and H. S. Melville.) [U. S. N. M.]

The specimen agrees very well with Karsch's description of this single African representative of the genus.

Rhombodera basalis (Haan).

1842. *Mantis* (*Mantis*) *basalis* Haan, in Temminck, Verhandel. Natuurlijke Geschiedenis Nederlandsche overzeesche bezittingen, p. 67. [Krawang, Java.]

Three specimens; two males, one female:

Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

Batu Sangkar, Tanah Datar, Padangsche Bovenland, Sumatra. August–September, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.]

Goenong Soegi, Lampong, Sumatra. October–November, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.]

The two male specimens have retained all of their original coloration, which is quite striking. The Trong specimen bears more yellowish than the Lampong male, but the amount of rose-color on the wings is about the same. The brown ring encircling the stigma mentioned by Wood-Mason[10] is not completely developed in the specimens examined.

Rhombodera megæra n. sp.

Type: ♀; Trong, Lower Siam. (Dr. W. L. Abbott.) [Cat. No. 6,956, U. S. N. M.]

Belonging to the same group as *flava* Haan, *major* Saussure, *lingulata* and *titania* Stål, *taprobanæ* Wood-Mason, and *pectoralis* Westwood, but closest related to *major* Saussure. The new form differs chiefly in the less expanded pronotum, and the different armature of the anterior coxæ.

Size large; form robust. Head slightly broader than high; occipital margin broadly arcuate; facial shield very slightly broader than high, the superior margin obtuse-angulate, and narrower than the base; ocelli rather small, the apex of the unequal triangle being inferior; eyes ovoid, moderately prominent; antennæ but slightly exceeding half

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[10] *Jour. Asiat. Soc. Bengal*, LI, p. 32.

the length of the pronotum. Pronotum rather stout, the greatest width at the supra-coxal dilations, the shaft about three times the length of the collar; anterior margin evenly rounded, posterior margin subtruncate; lateral portions very slightly expanded, and evenly decreasing in width both anteriorly and posteriorly from the supra-coxal portion; lateral margins feebly denticulate, more apparent anteriorly; lower face of the slight lateral expansions punctate and coriaceous; median carina moderately distinct on the shaft. Tegmina broad, coriaceous except immediately along the sutural margin and the central portion of the median half of the interspace between the principal branches of the ulnar vein; costal margin evenly arcuate, except the apical third, which is diagonally emarginate; apex narrowly rounded; ulnar vein with three principal rami; stigma elongate-ovate. Wings of moderate length, equalling the apex of the tegmina when at rest; costal margin straight, except in the apical third, where it curves posteriorly to the subangulate apex; anterior ulnar vein with three distinct and equally disposed rami. Abdomen moderately broad, the apex of the subgenital plate visible beyond the tips of the closed tegmina and wings. Supra-anal plate transverse, narrow, the apical margin slightly arcuate, the apex with a very shallow and almost imperceptible emargination. Cerci attenuate, moniliform, slightly exceeding the subgenital plate in length. Subgenital plate very broad, apex strongly compressed, rostrate. Anterior coxæ not quite equal to the shaft of the pronotum in length, superior margins, particularly the internal, denticulate, inferior margin with a series of rather large spines, which decrease in size distally and also take on an alternating large and small character; femora about equal to the shaft of the pronotum in length, apical genicular lobes considerably developed and armed apically with a slight, blunt, dentiform process, external inferior margin with four strong dentiform spines, discoidal spines four in number, internal inferior margin with a series of fifteen alternating large and small spines, the margin with a vacant distal diastema; tibiæ (without apical claw) about half the length of the femora, external margin bearing eleven or twelve spines, internal margin armed with fourteen spines; metatarsi considerably exceeding the remaining tarsal joints in length and almost equal to the tibiæ without apical claw. Genicular spine of median and posterior femora rather small; metatarsi of the median limbs very considerably less than the remaining tarsal joints, posterior limbs with the metatarsi, but slightly shorter than the remaining tarsal joints.

General color pea-green, of the most brilliant hue on the tegmina.

Eyes wood-brown. Stigma of the tegmina proximally and distally bordered with dark brown. Wings with the entire surface hyaline except the apex, which is suffused with pale greenish. Abdomen pale greenish-yellow. Anterior femora with alternate spines on the internal margin basally suffused with reddish-brown.

Measurements.

Total length,	91	mm.
Length of pronotum,	30.5	"
Greatest width of pronotum,	10.5	"
Posterior width of pronotum,	6.5	"
Length of anterior femora,	23	"
Length of tegmina,	51	"
Greatest width of tegmina,	18	"
Greatest width of costal field of tegmina,	6	"

The genus *Rhombodera* contains two structural types; one with the lateral expansion of the pronotum very distinctly developed, somewhat similar in superficial resemblance to that noticed in *Chæradodis* and *Deroplatys*, and the other with these expansions limited or subobsolete. In a species described by Brancsik, *R. tamolana*,[11] is found an annectant type, in which the lateral expansions are fairly well marked, but strictly confined to the anterior portion of the pronotum.

Genus **MANTIS** Linnæus.

1758. *Mantis* Linnæus, Syst. Nat., X ed., p. 425.

Type.—*Gryllus* (*Mantis*) *religiosus* Linnæus.[12]

Mantis religiosa Linnæus.

1758. [*Gryllus* (*Mantis*)] *religiosus* Linnæus, Syst. Nat., X ed., p. 426. ["Africa."]

Three specimens; two males, one female:

Chemulpo, Korea. August, 1890. (Dr. W. H. Jones.) [A. N. S. Phila.]

Yokohama, Japan. (Loomis.) [A. N. Caudell.]

Kioto, Japan. (Y. Hirase.) [A. N. S. Phila.]

These specimens are apparently the first Japanese records for this species. Saussure[13] has recorded individuals of *M. religiosa* from Ning-po, China, and "le sud de la Sibérie jusque sur les côtes orientales de l'Asie."

The specimen from Kioto, although a female, is much smaller than the male from Chemulpo, but this may be a character of the Japanese

[11] *Jahresh. Naturwiss. Ver.*, Tréncsen, XIX, p. 62, tab. 1, fig. 8.
[12] See Rehn, *Canadian Entom.*, XXXIII, p. 119.
[13] *Mélanges Orthoptérologiques*, fasc. III, p. 415.

individuals, as the male from Yokohama is considerably smaller than the Korean specimen.

Genus CALIDOMANTIS Rehn (= *Miomantis* Saussure).

1870. *Miomantis* Saussure, Bull. Soc. Entom. du Suisse, III, p. 228. (Not of Blanchard, 1842.)
1901. *Calidomantis* Rehn, Canad. Entom., XXXIII, p. 271.

Type.—*Mantis fenestrata* Fabricius.

Calidomantis menelikii (Bormans).

1881. *M[iomantis] Menelikii* Bormans, Ann. Mus. Civ. Stor. Nat. Genova, XVI, p. 209, fig. [Let Marefia, Scioa.]
1901. *Miomantis fenestrata* Rehn, Proc. Acad. Nat. Sci. Phila., 1901, p. 284. (Not of Fabricius.) [Luku, Gallaland.]

The two specimens recorded in the paper cited above prove to belong to Bormans' species. A very interesting character, omitted from Bormans' brief diagnosis, is the extremely short and transverse supra-anal plate.

Calidomantis equalis[14] **n. sp.**

Type: ♀; Zulu Mission, South Africa. [A. N. S. Phila.]

Allied to *C. semialata* (Saussure),[15] but differing in the more robust anterior portion of the pronotum, the higher and less depressed head, and the more equal and less arcuate costal field of the tegmina. The species described by Schulthess as *Miomantis saussurei*,[16] while very closely related to the new form, can readily be distinguished by the slender and attenuate anterior portion of the pronotum.

Size rather small. Head broad, compressed, the superior margin arcuate; eyes subtriangular in basal outline, the lateral portion slightly produced; antennæ minute, weak; facial scutellum strongly transverse, superior margin with a median rounded lobe flanked laterally by a concave sinuosity. Pronotum subequal in width, the anterior portion exceeding the posterior part in width and slightly less than half the length of the latter; anterior margin rotundate-truncate, lateral margins finely denticulate; amplication slight, rounded. Tegmina rather short, lanceolate, apex moderately acute; costal field subequal in width; anterior margin evenly and regularly arcuate. Wings about equal to the tegmina in length. Abdomen fusiform, moderately depressed; supra-anal plate elongate, lanceolate, extending to the tip of the compressed subgenital plate; cerci but slightly exceeding the supra-anal plate in length. Anterior coxæ about four-fifths the length of the pronotum, margins finely denticulate; anterior femora very

[14] In relation to the broad and equal anterior portion of the pronotum.
[15] *Mélanges Orthoptérologiques*, IV, p. 71, fig. 14.
[16] *Bull. Soc. Vaudoise Sci. Nat.*, 4e ser., XXXV, p. 197.

slightly shorter than the pronotum, rather heavy, third discoidal spine very robust, external inferior margin with four large spines, internal inferior margin with fourteen spines, one of which is apical and separated from the others by a considerable diastema; anterior tibiæ slightly less than half the length of the femora, armed on the external margin with seven spines placed on the median and apical portions, the internal margin armed with eleven to twelve evenly distributed spines; anterior metatarsi equal to two-thirds the length of the tibiæ and exceeding the remaining tarsal joints. Median and posterior limbs with the tibiæ slightly shorter than the femora, genicular spines slight.

General color dull yellowish-brown (specimen taken from alcohol). Anterior femora with four spots of black on the internal surface, one basal, two parallel and posterior to the ungual sulcus, the superior of these being the largest of any of the spots, and one anterior to the sulcus.

Measurements.

Total length,	28	mm.[17]
Greatest width of head,	5.5	"
Length of pronotum,	11.5	"
Greatest width of pronotum,	2.9	"
Length of tegmina,	12	"
Length of anterior femora,	10	"

Two other female individuals from the type locality have been examined.

Subfamily **Harpaginæ**.

Genus **DEROPLATYS** Westwood.

1840. *Deroplatys* Westwood, in Duncan, Introd. to Entomology, I, p. 234.

Type.—*Mantis* (*Deroplatys*) *desiccata* Westwood.

Deroplatys desiccata Westwood.

1840. *Mantis* (*Deroplatys*) *desiccata* Westwood, in Duncan, Introd. to Entomology, I, p. 234, Pl. 9. [Malacca.]

Two females; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

These two specimens represent two color phases; one a pale ochraceous and sienna blended to give a very effective "dead leaf" appearance, the other a dull brownish-purple, suffused on the tegmina with very dull greenish-gray.

[17] This is approximate, as the abdomen is considerably distorted.

ıroplatys angustata Westwood.

1845. *Deroplatys angustata* Westwood, Arcana Entomologica, I, p. 34, Pl. 9, fig. 2. [Java.]

One male; Goenong Soegi, Lampong, Sumatra. October–Novem-ɟr, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. hila.]

This specimen agrees exactly in the shape of the pronotum with ıe specimen figured by Westwood.

Genus **PHYLLOTHELYS** Wood-Mason.

1877. *Phyllothelys* Wood-Mason, Trans. Entom. Soc. London, 1877, p. xviii.

Type.—*Phyllocrania westwoodi* Wood-Mason.

ıyllothelys mitratum n. sp.

Type: ♀ (immature); Trong, Lower Siam. (Dr. W. L. Abbott.) ʻat. No. 6,972, U. S. N. M.]

Closely allied to *P. paradoxum* Wood-Mason,[18] but differing in the ırm of the facial shield and clypeus, and the shorter head.

Size rather small; form elongate, bacilliform. Head elongate; frontal rocess almost twice the length of the remainder of head, depressed, ıperior surface bearing a very distinct median foliaceous longi-ıdinal keel, lateral borders sinuate and bearing a distinct sub-basal ıd submedian angular lobe, lower surface with a median thickened rib; res sub-ovoid, apex inferiorly; facial shield slightly broader than ıgh, inferior margin evenly and slightly arcuate, superior margin ecidedly arcuate, surface bearing two blunt longitudinal carinæ; ypeus transverse, slightly broader superiorly than inferiorly, lateral ıargins sinuate, inferior margin subtruncate. Pronotum very slender, ıbequal, slightly expanding posteriorly; anterior and posterior bor-ers evenly rounded; lateral margins sparsely denticulate; supracoxal bes very slightly marked; median portion of the entire pronotum earing a faint longitudinal carina. Mesonotum and metanotum ightly depressed. Abdomen strongly depressed, greatest width at ıe fifth and sixth segments. Supra-anal plate transverse, the apex ctangularly produced and bearing a short longitudinal median carina. erci short, not exceeding the supra-anal plate, fusiform, depressed, pex acuminate. Subgenital plate transverse, evenly arcuate. An-erior coxæ slender, but slightly shorter than the pronotum, trigonal ı section, the inferior margin very weakly spined; femora slightly ınger than the coxæ, slender, superior margin straight, external ıargin with six spines, two of which are smaller than the others

[18] *Jour. Asiat. Soc. Bengal*, LIII, Pt. 2, p. 209, Pl. XII, fig. 3.

and placed on the genicular lobe, discoidal spines four in number, internal margin bearing fifteen spines, of which the apical is the largest; tibiæ about one-half the length of the femora, external margin bearing eleven and the internal thirteen spines; metatarsi about equal to the remaining tarsal joints in length. Median and posterior femora bearing lateral foliaceous crenulate expansions, genicular spines distinct; median and posterior tibiæ almost equal to their respective femora in length, basally inflated and tumid.

General color very dark wood-brown; inner face and lower surface of the anterior coxæ rich red-brown, the lower margin of the coxæ alternating ochraceous and black; anterior femora with the internal face brownish-black, bearing a large spot of ochraceous between the discoidal spines and the apex, and another smaller one at the base of the discoidal spines.

Measurements.

Total length (approximately),	26.7 mm.
Length of head,	5.5 "
Length of cephalic appendage (from the superior margin of the eyes),	3.5 "
Length of pronotum (approximately),	10.6 "
Greatest width of pronotum,	1.5 "
Greatest width of abdomen,	3 "
Length of anterior femora,	6.5 "

Genus PSEUDOCREOBOTRA Saussure.

1870. *Pseudocreobotra* Saussure, Bull. Soc. Entom. Suisse, III, pp. 241 and 242.

Type.—*Pseudocreobotra ocellata* (Palisot).

Pseudocreobotra wahlbergii Stål.

1877. *P[seudocreobotra] Wahlbergii* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, IV, No. 10, p. 85. [Caffraria; Zanzibar.]

Four specimens; adult male and female, two immature individuals; Zulu Mission, South Africa. [A. N. S. Phila.]

On comparison with these specimens, *P. amaræ* Rehn[19] from western Gallaland is seen to be a very distinct species. The two forms, which occupy quite different regions, may be separated as follows:

A.—Pronotum with the paired tubercles by the posterior margin distinct and dentiform; head with the frontal process considerably longer than the height of the clypeus; costal margin of the tegmina one and three-fourths millimeters in greatest width, *wahlbergii* Stål.

[19] *Proc. Acad. Nat. Sci. Phila.*, 1901, p. 286.

AA.—Pronotum with the paired tubercles by the posterior margin subobsolete; head with the frontal process considerably shorter than the height of clypeus; costal margin of the tegmina not over one millimeter in width, ... *amaræ* Rehn.

Genus **THEOPROPUS** Saussure.

1898. *Theopropus* Saussure, Revue Suisse de Zoologie, V, p. 204.

Included *T. elegans* (Westwood) and *T. præcontatrix* Saussure, of which the former may be considered the type.

Theopropus elegans (Westwood).

1832. *Blepharis elegans*[20] Westwood, in Griffith's Animal Kingdom, XV, p. 190, Pl. 78, fig. 3. [Tenasserim.]

One somewhat immature female; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

This species has also been recorded from Java by Saussure. The specimen measures as follows:

Total length (approximately),	27	mm.
Length of pronotum,	8	"
Greatest width of pronotum,	6	"
Greatest width of abdomen,	6.5	"
Length of anterior femora,	10	"

Genus **PARYMENOPUS** Wood-Mason.

1890. *Parymenopus* Wood-Mason, Ann. and Mag. Nat. Hist., 6th ser., V, p. 437.

Type.—*Parymenopus davisoni* Wood-Mason.

Parymenopus davisoni Wood-Mason.

1890. *Parymenopus Davisoni* Wood-Mason, Ann. and Mag. Nat. Hist., 6th ser., V, p. 437, Pl. XVII. [Singapore.]

One female; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

This specimen agrees very well with the description of the type except for the fact that the number of spines on the external margin of the anterior tibiæ is less (21 and 21 instead of 23), and the individual examined is of larger size.

Subfamily **Vatinæ**.

Genus **POPA** Stål.

1857. *Popa* Stål, Öfversigt K. Vetenskaps-Akademiens Förhandlingar, XIII, p. 169.

Type.—*Popa spurca* Stål. = *Mantis undata* Fabricius.

[20] By a typographical error misspelled *elegaus* in the text, but the plate bears the correct form.

Popa undata (Fabricius).

1793. [*Mantis*] *undata* Fabricius, Entom. Syst., II, p. 19. ["Tranquebar."]

Four specimens; three females, one immature individual; Zulu Mission, South Africa. [A. N. S. Phila.]

No difference can be detected on comparison with Somaliland and Gallaland specimens.

Genus **DANURIA** Stål.

1857. *Danuria* Stål, Öfversigt K. Vetenskaps-Akademiens Förhandlingar, XIII, p. 169.

Type.—*Danuria thunbergi* Stål.

Danuria thunbergi Stål.

1857. *D[anuria] Thunbergi* Stål, Öfversigt K. Vetenskaps-Akademiens Förhandlingar, XIII, p. 169. [Port Natal.]

One male; South Africa. [A. N. S. Phila.]

Subfamily **Empusinæ**.

Genus **IDOLOMORPHA** Burmeister.

1838. *Idolomorpha* Burmeister, Handb. d. Entom, II, p. 547.

Included *lateralis* Burmeister and *gracilis* Burmeister, of which the former may be considered the type.

Idolomorpha wahlbergi (Stål).

1857. *V[ates] Wahlbergi* Stål, Öfversigt K. Vetenskaps-Akademiens Förhandlingar, XIII, p. 167. [Port Natal.]

Two specimens; ♂ and ♀; Zulu Mission, South Africa. [A. N. S. Phila.]

NOVEMBER 3.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Two hundred and seventy persons present.

On a Collection of Anthropoids.—DR. HENRY C. CHAPMAN called attention to and described a fine collection recently presented by Dr. Thomas Biddle, consisting of mounted skins and skeletons of a gorilla, three chimpanzees and an orang utan, together with skeletons of man and a young orang utan. Comment was made on the peculiarities which ally man to the anthropoids or separate him from them, as shown in the skeleton, muscles, brain, viscera. The structure of the hand and foot of man as compared with the corresponding parts of the anthropoids was dwelt on at length.

MR. ARTHUR ERWIN BROWN spoke of the specific distinctions recognized among the anthropoids, their geographical distribution and habits. He explained the hypotheses which have been offered since Darwin to account for the stages in the phylogeny of the Anthropoidea, and spoke of certain characters in the teeth and vertebral column which appear to support Cope's view of their derivation directly from the Eocene lemuroids, without the intervention of catarrhine monkeys. Casts of the earliest known fossil human skulls were shown, and the opinion was expressed that the Neanderthal and Java men were distinctly intermediate types.

DESCRIPTIONS OF TWO NEW SPECIES OF POLYCHÆTA FROM WOOD'S HOLE, MASSACHUSETTS.

BY J. PERCY MOORE.

Nereis arenaceodentata n. sp.

A small, slender species, seldom exceeding an inch in length. The head (Pl. XL, fig. 1) is about as long as broad, roughly quadrate, with the posterior side about $1\frac{1}{2}$ times the anterior, which is strongly convex, the lateral borders bulging posteriorly, excavated and wrinkled anteriorly. The two pairs of conspicuous, black, broadly elliptical eyes are almost in contact near the postero-lateral angles of the head; the anterior somewhat more widely separated and slightly the larger. Frontal tentacles about $\frac{2}{5}$ head, slender, conical, divergent; their bases separated by about twice their diameter. Palps thick, swollen at the base, conical but suddenly constricted and bent at the terminal third; the style minute and retracted but reaching beyond the frontal tentacles. Tentacular cirri all relatively short and moderately slender, with very short crowded basal pieces; the anterior dorsal is about equal to the head; the anterior ventral about $\frac{3}{4}$, the posterior dorsal about twice and the posterior ventral about $\frac{3}{5}$ as long. The buccal region is swollen and wrinkled.

At the anterior end a region of the body comprising the first 4 or 5 somites is considerably enlarged and quite terete; the body then rapidly narrows to about somite X, beyond which it is nearly linear and of uniform diameter to near the caudal end. At first the parapodia are small, but increase in length as the width of the body diminishes, so that the total width remains nearly uniform. Beyond the first third the length of the parapodia equals the width of the body and the animal assumes a depressed aspect. The caudal end terminates quite abruptly in a short pygidium bearing a pair of anal styles equal in length to the last 8 or 9 segments. There are 49 setigerous somites in the type.

The parapodia are all distinctly biramous. In the first (fig. 2) the notopodium is relatively small and simple and is achætous and lacks an aciculum; it consists of a short cylindrical base bearing a single conical lobe, and an equally long, but more slender, dorsal cirrus. The neuropodium is larger, contains an aciculum and bears setæ;

besides a short, thick, blunt acicular lobe it bears a posterior and a ventral lobe, both of which are bluntly conical and have their free portions subequal. The ventral cirrus, borne at the base of the neuropodium, is rather thick with a constricted base, and reaches the tip of the acicular lobe.

The next two or three parapodia change quickly, and by the fifth (fig. 3) the typical form is attained. The bases of both rami are longer and deeper, and in the neuropodium the posterior lobe has lengthened so that it reaches distinctly beyond the ventral lobe; both lobes are more pointed. The notopodium exceeds the neuropodium in size and complexity, having a short, posterior acicular lobe and three pointed conical processes, of which the dorsal is the largest, the ventral as long but more slender, and the anterior, which lies immediately before the fascicle of setæ, much the smallest. The slender dorsal cirrus is nearly as long as the dorsal lobe, from just within the base of which it arises.

In succeeding parapodia, besides a general increase in size many changes in proportion of parts take place. The two rami become more elongated and crowded together, as shown in the thirtieth parapodium (fig. 4). Here both dorsal and ventral cirri have become much more slender and reduced to a length of $\frac{1}{3}$ or $\frac{1}{4}$ of the parapodium, and the former is carried much farther out than in preceding somites; the neuropodial acicular lobe is very prominent, with a distinct presetal process and bears the posterior lobe as a postsetal process, while the ventral lobe has undergone little alteration beyond being more pointed. The notopodium is nearly twice as deep as the neuropodium, beyond which it also extends; the largely developed acicular lobe bears the pointed, now subequal, anterior and ventral lobes as presetal processes; the dorsal lobe stands more apart as a broad, triangular, somewhat flattened piece. Still farther caudad all of the lobes shrink in size and become elevated on a longer basal region.

Except the notopodium of the first, each ramus of every parapodium contains a single aciculum which is simple, slender, tapering and colorless.

There are two kinds of setæ, both having rather slender, slightly curved, transparent, colorless and camerated shafts. In one form (fig. 8) the blades are very long, slender and acute, especially in the middle region of the body, with one margin delicately fringed; the shafts, as compared with the other kind, are longer, more slender and have the margins of the socket of nearly equal height all around. The other form (fig. 7) has the shaft somewhat stouter and more curved, the end

more distinctly enlarged and the margin of the socket very oblique; the appendage is never more than $\frac{1}{2}$ as long as in the first kind, and is usually $\frac{1}{3}$ or $\frac{1}{4}$ as long, is more distinctly fringed and terminates abruptly in a rather coarse hook. The entire seta is less than or only equal to the shaft alone of the first kind.

The short setæ occur in both notopodium and neuropodium and in both dorsal and ventral fascicles of the latter. The first parapodium lacks notopodial setæ altogether and only 1 to 3 of this kind are found in the neuropodium. In the notopodium of the fifth 5 or 6 occur, and in the neuropodium there are 3 or 4 in the dorsal part of each fascicle. Toward the middle of the body the number increases, the twentieth parapodium supporting about 30 in a spreading fan-shaped notopodial bundle and 6 to 8 in the dorsal part of each neuropodial fascicle. The thirtieth foot shows a slightly increased number, which by the fortieth has fallen to about 8 in each ramus. The second form of seta is restricted to the neuropodium, the dorsal bundle of which contains from 3 to 5 and the ventral bundle from 12 to 20 in the first thirty parapodia, while the single bundle of the fortieth contains but 3 altogether.

There is nothing characteristic about the jaws, which have the usual brown color and curved form with a broad base, acute terminal fang and 6 or 7 smaller teeth. The paragnatha (figs. 5 and 6) are very characteristic. All of the areas of the basal ring have united into a continuous zone somewhat narrower on the dorsum, covered thickly and uniformly with small, grainlike, bluntly conical, horny papillæ (fig. 9), measuring from .03 mm. to .04 mm. in height and the same in diameter. On the maxillary ring the usual six areas are distinctly differentiated. The paragnatha of the 3 dorsal areas especially are distinctly coarser and more elevated (fig. 10), those of the most anterior rows being largest and strongly hooked. The median dorsal area has the form of an ellipse, about twice as wide as long and formed of about six transverse rows of about six each, except at the ends. The dorso-lateral areas are narrowly crescentic, composed of few paragnaths, but the anterior ones the largest and most strongly hooked of all. The median ventral is nearly circular, composed of numerous small paragnaths similar to those of the basal row and arranged in curved transverse rows. Finally the ventro-lateral areas are drop-shaped with the base toward the jaws and a slender pointed tail. None of the specimens had the proboscis protruded and the arrangement of the paragnatha had to be determined by dissection. Some allowance must therefore be made for distortion of the form of the areas on the folded surface.

The type specimen is 22 mm. long, 2.3 mm. between the tips of the parapodia without setæ and .7 mm. in width of body in the middle region.

The small size of the species might lead to the belief that it is an immature phase of another species, but any doubt as to its distinctness is dispelled by the presence of large numbers of mature ova in the cœlom of many specimens. The species occurs occasionally on mussel beds just below low water and was found quite commonly during the latter part of August, both of 1902 and 1903, swimming at the surface of Wood's Hole harbor with other species of sexually mature nereids and syllids.

Loimia viridis n. sp.

In the preserved state the body is rather slender and regularly tapering, the thoracic region passing easily into the abdominal without any sudden diminution in size, though the former is circular in cross-section, the latter flattened below and highly arched above. The first thirteen somites are smooth and not annulated, the remaining thoracic and first two abdominal (which are longer than the succeeding ones) strongly but somewhat irregularly subdivided. Apparently there are three primary annuli, the middle one of which bears the parapodia and an irregular zone of sense organs. Each is divided into two or three very short, often incomplete annuli. This condition passes gradually into the typical biannulate arrangement of the middle abdominal somites, in which a somewhat larger posterior annulus bears the parapodia and sensory zone. Toward the caudal end the somites become very short and simple. The anus is small and surrounded by four very short papillæ.

There are nine ventral plates, the first corresponding to somites II to V, the limits of which are indicated by faint grooves, and extending high upon the sides. Successive plates become gradually narrower and longer, the second being three times as wide as long, while the eighth is as long as the width of its anterior and one and one-half times its posterior end. The ninth is narrow, transversely wrinkled and ends opposite the middle of somite XIII. All of the ninth and the posterior half of the eighth are highly vascular. Dorsad of the ventral plates on each side is a whitish, thickened glandular area anteriorly including the bases of the branchiæ and nearly meeting on the dorsum. Posterior to the branchiæ they quickly become narrowed and restricted to the region of the parapodia and disappear altogether at about XII or XIII.

The prostomium surrounds the mouth completely and consists of a

broad, flat, smooth dorsal lobe projecting prominently over the mouth, and much shorter thin lobes on each side which meet in the middle line below and join the peristomium by a narrow isthmus. Tentacles numerous but small, borne on rather restricted areas which meet in the middle line and extend on each side of the posterior part of the prostomium. In the preserved specimen the length of the tentacles is less than the diameter of the branchial region. They are attached by contracted bases in the same manner as Andrews has described for *L. turgida*. There is no post-tentacular fold and no eyes.

The peristomium is largely retracted within the free margin of the first ventral plate, from which it projects as a pair of thin lobes which widen dorsally and conceal the ventral limb of the prostomium; on the dorsal side the peristomium is scarcely recognizable.

Three pairs of branchiæ occur on somites II, III and IV; the first is very large, with a length exceeding the diameter of the body at that point, while the third is scarcely one-fifth as long. They are tall arboriform, each with a stout, tapering, irregularly bent stem bearing irregularly alternate branches (5 on the 3d to 11 on the 1st), each of which again divides in the same irregular manner 3 or 4 times, resulting in very numerous, fine and densely tufted terminal twigs.

The first parapodium is merely a setigerous tubercle just beneath the third branchia. The remaining thoracic ones have rather prominent dorsal setigerous tubercles and uncigerous tori which are at first short, but increase in length and shift ventrad as the ventral plates diminish in size; posterior to the region of the ventral plates these tori become more elevated and nearly meet in the ventral mid-line. The abdominal uncigerous tori are truncate, flattened tubercles projecting caudad from the posterior margin of the somites on the ventro-lateral angle, the caudal members of the series becoming minute.

The setæ (fig. 11) of each tuft are arrranged in two vertical rows, one composed of more slender, the other of stouter setæ. The former are nearly colorless, slightly curved, axially faintly striated and have a very narrow marginal wing. The latter are yellowish, nearly straight, rapidly tapering in the exposed part, doubly winged, both wings being obliquely striated and one much wider, the core strongly marked with parallel longitudinal striations and the superficial fibers radiating in all directions to the surface which, as a consequence, has the appearance of being regularly marked with rows of fine granules or very short lines.

On somites XI to XX the uncini are in two rows, on V to X inclusive and caudad of XX in but one row. On the posterior thoracic somites

they are very numerous, each torus of somite XX, for example, containing upward of 400, while on XXI, the first abdominal somite, there are but 80. As usual in the genus, they have the form of flat pectinate plates (figs. 12, 13 and 14) set on edge in the integument with the curved teeth exposed, but they are broader apically than in most species and usually have 6 well-developed teeth, the apical one the smallest and occasionally absent, the basal one much the stoutest, the base strongly convex with a prominent posterior process and a small tubercle usually present beneath the lowermost tooth.

The total length of the type is 107 mm., width in the branchial region 7.5 mm., width at somite XXI 4 mm., number of somites 92, of which 20 are thoracic and 72 abdominal; somites V to XX are setigerous and uncini are present on all somites beginning with V.

The color when living is olive-green, purest in the posterior region, becoming lighter and more or less tinged with red or yellow anteriorly as a result of the blood-vessels showing through the integument. The tori, particularly on the somites bearing capillary setæ, are greenish-yellow edged with a narrow red blood-vessel which forms a red spot dorsad of the fascicles of setæ. The ventral plates are yellowish or olive-buff with the prominent anterior border pale green and the furrows and a narrow lateral edging blood-red, while a deep red clot-like spot covers a narrow area extending over the middle ventral portion of somites XII, XIII and XIV, from which a distinct red line marks the course of a subneural vessel to XXI. The lower lip is green, the upper red, the tentacles pale pink. The branchiæ have red stalks with green or white branches.

From most of the nine undoubted species of the genus which have been described from various parts of the world *L. viridis* is distinguished by its color. From *L. turgida* Andrews, the only species hitherto taken on the Atlantic coast of the United States, the shape of the uncini and the absence of dark pigmented rings on the tentacles afford the best distinctions.

The only example of this species known was found by Mr. George Gray burrowing in a soil of sandy mud with *Amphitrite ornata* below low water at Ram Island, Wood's Hole, on August 4, 1902. Repeated search since then has failed to bring any additional specimens to light, and as it is a very conspicuous species it must be quite rare or inhabit some locality hitherto unexplored. When brought to me this example occupied a thick mud tube nearly indistinguishable from that of *Amphitrite*.

The types of these two species are in the collection of this Academy.

Explanation of Plate XL.

Nereis arenaceodentata.

Fig. 1.—Dorsal view of anterior end. × 32.

Figs. 2, 3 and 4.—Outlines without setæ of the 1st, 5th and 30th parapodia respectively, from cephalic side. × 56.

Figs. 5 and 6.—Dorsal and ventral aspects respectively of protruded proboscis, showing the arrangement of the paragnatha; from a dissection. × 32.

Figs. 7 and 8.—Examples of the two kinds of setæ, from somite XX. × 1200. Many of the stouter sort have the appendage much shorter.

Fig. 9.—Several of the paragnatha from the basal zone. × 360.

Fig. 10.—The same from the median dorsal maxillary area. × 360.

Loimia viridis.

Fig. 11.—One of the stouter setæ from somite X. × 250. These setæ are seldom so straight as represented in the drawing, which has been somewhat diagrammatized from a camera sketch.

Figs. 12, 13 and 14.—Three uncini from the dorsal, middle and ventral regions respectively, of a torus of somite XXVI. × 360. These show nearly the extremes of variation, figure 13 being the most usual form, but slightly foreshortened.

DESCRIPTIONS OF NEW, LITTLE KNOWN, AND TYPICAL ATHERINIDÆ.

BY HENRY W. FOWLER.

The material on which the present paper is based is all contained in the collections of the Academy of Natural Sciences of Philadelphia.

ATHERINIDÆ.

Subfamily Atherininæ.

Premaxillaries freely protractile, skin not continuous with that of forehead.

ATHERINA Linnæus.

Subgenus ATHERINA Linnæus.

Type *Atherina hepsetus* Linnæus.

Rami of mandible elevated inside of mouth.

Atherina lacustris Bonaparte.

Fauna Italica, Pesc., III, xvii, xviii, 1836, descr., Pl. 91, fig. 3. Albano, Nemi. [Lakes in Italy.]——Bonaparte, Cat. Met. Pesc. Europ., 1846, p. 57. Lace. Nem. Alb. Bols. [No descr.]

Head $4\frac{1}{5}$; depth $6\frac{1}{8}$; D. VIII–I, 10; A. I, 12; P. I,.12; V. I, 5; scales 48 to base of caudal; 21 before spinous dorsal; 10 between latter and base of ventral; width of head 2 in its length; depth of head $1\frac{1}{2}$; snout 4; eye 3; maxillary $2\frac{1}{2}$; interorbital space $3\frac{1}{2}$; pectoral $1\frac{2}{5}$; ventral $1\frac{3}{4}$; caudal peduncle from last dorsal ray a little shorter than head; least depth of caudal peduncle 4.

Body elongate, slender and greatest depth about base of ventral fin. Side compressed, somewhat flattened. Caudal peduncle elongate, compressed, and least depth near base of caudal.

Head elongate, rather deep, and blunt in front. Width of head posterior to eyes much wider than anterior portion and a little wider than any portion of trunk. Sides of head compressed, somewhat constricted below. Snout above, and interorbital space, flattened, and with three low longitudinal ridges, but not extending posteriorly beyond eyes. Top of head posterior to eyes convex. Snout rather large, conic, not much broader than deep. Eye rather large, anterior, hardly impinging on upper profile. Mouth moderately large, oblique, and lower jaw protruding. Maxillary narrow, reaching below front

rim of orbit. Mandible rather small, not broad, and each ramus elevated inside of mouth. Teeth minute, jaws forming a thin narrow cutting edge. No teeth on vomer and palatines. Tongue far back in mouth, rather small, elongate, free along sides, and united by median frenum with floor of mouth. Nostrils lateral, in front of eye above. Interorbital space a trifle broader than snout, and flattened. Postocular ridge distinct.

Gill-opening large, carried forward till about under front rim of orbit. Rakers long, slender and numerous on first arch. Filaments numerous, about equal to rakers in length. Pseudobranchiæ large, much longer than filaments. Isthmus long and narrow. Branchiostegal membranes united by narrow frenum in front. Lower surface of isthmus with a shallow groove.

Scales large, thin, cycloid, and not imbricated. Three rows on cheek. Opercles scaled, and top of head posteriorly scaled to eyes. Snout, interorbital space, jaws, and lower hyal region naked. Snout, both above and on sides, together with interorbital space with cavernous bones, ridges connected by soft membranes. This region also furnished with pores. Pectoral without flap. Ventrals with rather short scaly flap between their bases, and each with a small short axillary scale.

Origin of spinous dorsal nearer tip of snout than base of caudal by length of ventral. Spines pungent, slender, third and fourth longest and subequal. Soft dorsal inserted a little behind anal, much nearer origin of ventral or spinous dorsal than base of caudal, and second ray highest. Anal inserted nearer base of caudal than origin of pectoral, and anterior rays highest. Caudal rather small, deeply emarginate. Pectoral broad, level with eye, and reaching over origin of ventral. Ventral reaching under posterior portion of spinous dorsal or half way to origin of anal. Anus well posterior or a little nearer tip of ventral than origin of anal.

Color in alcohol pale brown, sides of head and trunk more or less pale silvery. Back specked with small dark brown dots. Side with longitudinal narrow silvery band about as wide as pupil of eye extending to base of caudal. Fins plain pale brown. Peritoneum black.

Length (caudal damaged) $4\frac{3}{16}$ inches.

Type of *Atherina lacustris* Bonaparte, No. 9,953, A. N. S. P. Italy. Bonaparte Coll. (No. 341). Dr. T. B. Wilson.

Twenty-one co-types with same data.

Thirty-eight examples, also from Italy, with the same data except that the lake from which they were taken is not given. (No. 348.)

Three examples from Bracciano, the data otherwise like preceding. (No. 348.)

Ninety-five examples from Italy, also with same data. (No. 412.)

This species, originally from the lakes in the State of Rome, is easily distinguished from the other species of *Atherina* by the slender body.

Atherina sardinella sp. nov. Plate XLI (upper figure).

Head 4; depth 5; D. VII–I, 11; A. I. 13; P. I, 12; V. I, 5; scales 46 to base of caudal; 20 before spinous dorsal; 10 between spinous dorsal and base of ventral; width of head $2\frac{1}{10}$ in length; depth of head $1\frac{1}{2}$; snout $3\frac{1}{3}$; eye $3\frac{1}{3}$; maxillary $2\frac{2}{5}$; interorbital space $3\frac{1}{3}$; pectoral $1\frac{4}{5}$; ventral 2; caudal peduncle, from base of last dorsal ray, a little shorter than head; least depth of caudal peduncle $4\frac{1}{2}$.

Body elongate, fusiform, greatest depth about ventral fin. Sides compressed, slightly flattened. Caudal peduncle elongate, slender, compressed, and its least depth near base of caudal.

Head elongate, attenuate, compressed, not broad behind eyes where greatest width is found. This is also widest part of body. Side of head more or less flattened and constricted below. Snout above, and interorbital space flattened, with three low longitudinal ridges extending posteriorly over latter but not beyond eyes. Top of head posterior to eyes and interorbital space convex. Snout long, conic, pointed and not broad. Eye moderately large, anterior, and hardly impinging on upper profile. Mouth moderate, oblique, and lower jaw protruding. Maxillary narrow, slightly curved, and reaching posteriorly a little beyond front rim of orbit. Mandible conspicuous, moderately large, not broad, and each ramus elevated somewhat inside of mouth. Teeth distinct, small, sharp-pointed, conic, and in several series forming narrow bands in jaws. Vomer with conspicuous patch of small conic pointed teeth. Palatines with short narrow band of similar teeth. Tongue with small patch of minute pointed teeth, rather far back. Tongue small, far back in mouth, elongate, free along sides, and united with floor of mouth by a median frenum. Nostrils lateral, rather high, and in front of eye above. Interorbital space a little wider than snout. Postocular ridge distinct.

Gill-opening large and carried forward till nearly below front rim of orbit. Gill-rakers long, compressed, slender, numerous, and longer than longest gill-filaments on first arch. Gill-filaments numerous, and short on hypo and ceratobranchials. Pseudobranchiæ large, much longer than longest gill-filaments. Isthmus long, narrow, branchiostegal membrane united by a narrow frenum in front. Lower surface of isthmus with rather broad groove.

Scales large, thin, cycloid, and not especially imbricated. Two rows on cheek. Opercle and top of head till behind eyes and interorbital space also scaled, rest of head naked. Snout and interorbital space more or less cavernous, bony ridges connected by soft membranes furnished with pores. Pectoral without scaly flap at axil. A single rather small scaly flap between bases of ventrals.

Origin of spinous dorsal nearer tip of snout than base of caudal. Dorsal spines slender, third probably longest, and fin reaching about $\frac{3}{5}$ of distance to origin of soft dorsal. Soft dorsal inserted posterior to origin of anal, much nearer origin of spinous dorsal than base of caudal, and anterior rays much higher than others. Anal with anterior rays longest. Caudal emarginate. Pectoral rather broad, high, and reaching about opposite root of ventral. Ventral small, inserted much nearer origin of anal than posterior rim of orbit. Anus placed about first third of space between tip of ventral and origin of anal.

Color in alcohol pale brown, more or less dull silvery, especially below. Side of body with a narrow silvery longitudinal band, nearly as wide as pupil of eye, extending to base of caudal. Fins pale brown, without markings. Each scale on back with a number of fine dark dots. Peritoneum silvery.

Length (caudal damaged) $4\frac{5}{16}$ inches.

Type No. 15,397, A. N. S. P. Italy. Bonaparte Coll. Dr. T. B. Wilson.

Twenty-nine co-types with same data.

Ten examples. Same data. (No. 345.) Identified as "*Atherina sarda.*"

This species may be found identical with *Atherina sarda* Valenciennes, but the latter is said to have D. VI–9, A. 10. The description, like that of *Atherina corneda* Rafinesque, is too imperfect to permit of identification.

(*Sardinella*, diminutive of *Sardina*, a sardine.)

ATHERINOMORUS subgen. nov.

Type *Atherina laticeps* Poey.

Rami of mandible not elevated inside of mouth. Anus well anterior to tips of ventrals. Head broad. Eyes large.

(*Ἀθερίνη*, Atherina; *ὅμορος*, near.)

ISCHNOMEMBRAS gen. nov.

Type *Ischnomembras gabunensis* sp. nov.

A single row or series of scales on cheek. Mandible slightly protruding. Mouth curved in profile. Eye large. Scales moderate. Peritoneum pale. Anal rather long. Apparently near *Chirostoma*.

('Ἰσχνὸς, slender; *Μεμβρὰς*, *Membras*, an old name congeneric with *Atherina*.)

Ischnomembras gabunensis sp. nov. Plate XLII (upper figure).

Head $3\frac{3}{4}$; depth 6; D. VI–I, 9; A. I, 16; P. I, 13?; V. I, 5; scales about 40 (squamation injured), to base of caudal; about 14 before spinous dorsal; 7 between second dorsal and origin of anal; width of head $2\frac{1}{8}$ in its length; depth of head $1\frac{4}{5}$; snout $3\frac{2}{5}$; eye $3\frac{1}{4}$; maxillary 3; width of mouth $4\frac{1}{8}$; interorbital space $3\frac{1}{2}$; pectoral $1\frac{1}{2}$; ventral 2; length of caudal peduncle a little less than head; least depth of caudal peduncle $3\frac{1}{3}$.

Body rather elongate, compressed, and slender. Sides slightly convex. Caudal peduncle elongate, compressed, and its least depth about $\frac{2}{5}$ its length.

Head large, elongate, conic, depressed above, compressed laterally and broadly constricted below. Greatest width, also greatest width of body, at postocular region. Side of head more or less flat. Top of head smooth, without conspicuous ridges, and slightly convex till behind eyes. Snout rather long, pointed, and broadly depressed. Eye rather large, anterior, and close to upper profile. Mouth large, oblique, and mandible slightly protruding. Premaxillaries protractile. Front of upper jaw depressed. Mouth curved in profile. Maxillaries narrow, small, and not reaching opposite front rim of orbit. Mandible expanded anteriorly till as wide as upper jaw, and each ramus elevated rather high inside of mouth. Teeth minute, in narrow bands along edges of each jaw, and none on vomer and palatines. Tongue moderately long, flattened, free in front, and placed rather far back. Nostrils well separated, lateral, anterior circular about half-way in length of snout, and posterior a small slit above eye in front. Interorbital space scarcely wider than snout. Postocular ridge distinct.

Gill-opening large, carried forward below middle of orbit. Rakers short, small, not much more than half of length of filaments and moderate. Filaments long. No pseudobranchiæ. Isthmus narrow and trenchant below, and anteriorly gill-membranes united across for short distance.

Scales small, thin, cycloid, and somewhat imbricated. Top of head scaled, but scales not extending forward to eye. Opercles scaled, and row of broad scales on cheek. Snout and interorbital space naked, not especially cavernous, and without any ridges.

Origin of spinous dorsal nearer tip of snout than base of caudal. Dorsal spines weak, somewhat pungent, and when depressed fin reaches $\frac{3}{4}$ of distance to soft dorsal. Second and third spines longest. Soft

dorsal inserted before middle of base of anal, and anterior rays highest. Anal large, inserted much nearer base of caudal than tip of snout, and first rays highest. Pectoral elongate, pointed, and reaching a little beyond root of ventral. Ventral rather small, reaching about $\frac{2}{5}$ of space to anal fin. Caudal emarginate. Anus placed nearer tip of ventral than origin of anal fin.

Color in alcohol uniform pale brown, with traces of silvery, especially on lower surface and side of head. A narrow silvery band, not wider than pupil, extending along side to base of caudal. Fins pale brown. Peritoneum silvery.

Length $2\frac{5}{16}$ inches.

Type No. 14,934, A. N. S. P. Gabun river, Gabun country, West Africa. P. B. DuChaillu.

Two examples inclusive of type.

(*Gabunensis*, of the Gabun river.)

PHOXARGYREA gen. nov.

Type *Phoxargyrea dayi* sp. nov.

Peritoneum silvery, otherwise close to *Menidia*.

(Φοξός, tapering; Ἀργυρέα, *Argyrea*, an old name applied to *Menidia*, from silver, or made of silver.)

Phoxargyrea dayi sp. nov. Plate XLI (lower figure).

Head $4\frac{3}{5}$; depth $6\frac{1}{2}$; D. IV–I, 10; A. I, 24; P. I, 13; V. I, 5; scales 48 to base of caudal; 28 before spinous dorsal counting from interorbital space; about 9 obliquely between spinous dorsal and anal; width of head $2\frac{1}{8}$ in its length; depth of head $1\frac{3}{4}$; snout 3; eye $3\frac{3}{5}$; maxillary $3\frac{7}{8}$; interorbital space $3\frac{1}{3}$; pectoral $1\frac{1}{8}$; ventral 2; length of caudal peduncle from last dorsal ray a little over length of head; least depth of caudal peduncle $3\frac{1}{4}$.

Body elongate, slender, compressed, and greatest depth about origin of anal. Side compressed, and more or less flattened. Caudal peduncle elongate, narrow, compressed, and its least depth midway in its length.

Head elongate, compressed, attenuate, rather narrow, flattened above in front, then convex posteriorly and sides flattened. Top of head smooth, without ridges. Snout elongate, conic, and somewhat flattened above. Eye moderately large, a little anterior, and not impinging on upper profile. Mouth rather small, oblique, and jaws subequal in closed mouth. Premaxillary broad posteriorly, its edge strongly curved. Corner of mouth about midway between tip of snout and front rim of orbit. Mandible rather small, not forming a

beak with upper jaw, and each ramus elevated inside of mouth. Lips thin, fleshy at corner of mouth. Teeth small in jaws, those in front of upper curved downward. Vomer and palatines edentulous. Tongue far back, flattened, elongate, rounded, and free in front. Nostrils lateral, above and in front of eyes. Interorbital space broad, slightly convex. Postocular ridge not distinct.

Gill-opening rather large, carried forward till below middle of eye. Rakers fine, numerous, and slender on first arch. Filaments moderately long, or about equal to rakers, and numerous. No pseudobranchiæ. Isthmus a long, narrow, sharp-edged keel anteriorly. Branchiostegal membranes united for short distance at first, also adnate by means of frenum to anterior portion of isthmus.

Scales small, cycloid, not imbricated, and smooth. Head scaled, with exception of jaws, snout, and under surface. Bones of snout and front of head above more or less cavernous. Several pores present. Axil of pectoral without flap. Ventrals close together, without median scaly flap.

Origin of spinous dorsal a little nearer tip of snout than base of caudal. Dorsal spines pungent, slender, rather weak, and first and second longest. Origin of soft dorsal nearly midway between that of spinous dorsal and tip of last depressed anal ray. Anterior rays highest. Anal long, beginning just above base of last dorsal spine, or a little nearer base of caudal than tip of snout. Length of its base a little less than $\frac{1}{3}$ of body without caudal. Anterior rays highest. Caudal broad, emarginate. Pectoral large, elongate, reaching well beyond root of ventral, but not to origin of dorsal. Ventral shorter, reaching to anus or not quite to origin of anal. Anus directly in front of anal fin or at tip of depressed ventral.

Color in alcohol pale, more or less uniform brown. Side of body with a well-defined narrow silvery-white longitudinal band about width of pupil, and extending to base of caudal. Fins uniform pale brown. Peritoneum bright silvery.

Length (caudal damaged) $3\frac{1}{2}$ inches.

Type No. 10,177, A. N. S. P. India. R. Coates.

One example, the type.

(Named for Dr. Francis Day, among late Ichthyologists a most able author of many papers on Indian fishes.)

BASILICHTHYS Girard.

Proc. Acad. Nat. Sci. Phila., 1854, p. 198 (*microlepidotus*).

Basilichthys regia (Humboldt and Valenciennes).

Atherina regia Humboldt and Valenciennes,[1] in Humboldt and Bonpland, Rec. Obs. Zool. Anat. Comp., II, 1833, p. 187. Surtout dans l'Océan-Pacifique, près du Callao de Lima.

Atherina laticlavia Valenciennes, Hist. Nat. Poiss., X, 1835, p 351. Valparaiso. (M. d'Orbigny.) La lagune de Taguatagua du Chili. (M. Gay.)——Cope, Proc. Amer. Philos. Soc., XVII, 1878, p. 44. Callao Bay. Peru. (Prof. James Orton.)

Atherinichthys laticlavia Günther, Cat. Fish. Brit. Mus., III, 1861, p. 402. Salt water, Valparaiso. (Mr. Bridges.) Falkland Islands, Port Louis. (Haslar Collection.)

Chirostoma laticlavia Steindachner, Zool. Jahrb., Suppl. IV (Fauna Chilensis), 1898, p. 313. Tumbes (Talcahuano).

Head $4\frac{2}{5}$; depth $4\frac{4}{5}$; D. VIII–I, 50; A. I, 18; P. I, 14; V. I, 5; scales 92 in lateral series to base of caudal; 50 before spinous dorsal; 16 in transverse series between root of ventral and middle of back before spinous dorsal; width of head $2\frac{1}{5}$ in its length; depth of head $1\frac{4}{5}$; snout 3; eye $5\frac{1}{2}$; tip of upper jaw to corner of mouth 5; to end of maxillary 3; interorbital space $3\frac{2}{3}$; length of depressed spinous dorsal 3; first dorsal ray $2\frac{1}{2}$; base of soft dorsal $2\frac{1}{2}$; second anal ray $2\frac{2}{5}$; base of anal $1\frac{6}{7}$; pectoral $1\frac{2}{5}$; ventral $2\frac{2}{3}$; least depth of caudal peduncle $3\frac{1}{3}$; length of caudal peduncle, from base of last dorsal ray $1\frac{1}{5}$.

Head large, elongate, compressed, greatest depth about tip of pectoral. Sides compressed, somewhat flattened, or only slightly convex. Caudal peduncle elongate, compressed, its least depth near base of caudal.

Head elongate, conic, compressed, rather broad posteriorly so that greatest width is about midway in postocular region, also widest part of body. Side of head more or less flattened, though broadly constricted below. Snout rather long, flattened above, and with jaws produced some distance beyond. Eye small, high, not impinging on upper profile, and posterior rim a little posterior in head. Adipose eyelid slightly developed. Mouth rather small, horizontal, and jaws equal. Maxillary expanded distally till $\frac{2}{3}$ of pupil, upper portion more or less concealed below preorbital, and not reaching opposite front rim of orbit. Teeth conic, rather large, and in two rather irregular series in jaws. No teeth on vomer or palatines. Tongue small, narrow, pointed, rather thick, and free in front. Mandible moderately large, with each ramus well elevated inside of mouth. Lips thin. Anterior

[1] Credited to Humboldt on the authority of Valenciennes. The paper in which this species is described is by these authors jointly, but later Valenciennes credits to Humboldt.

nostril circular, about last third of space between tip of upper jaw and front rim of orbit. Posterior nostril slit-like and a little before front rim of orbit above. Interorbital space broad, slightly convex. Top of head posterior to interorbital space evenly convex.

Gill-opening large, extending forward nearly opposite front rim of pupil. Rakers long, slender, compressed, $8+25$ on first arch, longest about $\frac{4}{5}$ of longest filaments. No pseudobranchiæ. Isthmus long, narrow, trenchant and branchiostegal membranes not united across.

Scales small, thin, cycloid, and rather narrowly imbricated. No lateral line. Head, with exception of snout, jaws and space in front of eyes, scaled. About five series of scales on cheek. Base of caudal covered with small scales, none on other fins. Between bases of ventrals several small scales, and each fin with a small axillary scale. No pectoral flap.

Spinous dorsal a little posterior, its origin a little nearer base of caudal than tip of upper jaw, weak, depressable in a groove, and reaching $\frac{2}{5}$ of distance to soft dorsal. Soft dorsal with anterior rays elevated and inserted about midway between base of caudal and origin of ventral or over middle of base of anal. Anal inserted posterior to tip of depressed spinous dorsal, and anterior rays longest. Caudal moderately large, forked, and lobes rounded. Pectoral small, high, and reaching about $\frac{2}{3}$ of distance to origin of ventral. Ventral small, inserted nearer origin of anal than origin of pectoral, and reaching hardly half-way to anus. Anus as far from tip of ventral as length of that fin or just before origin of anal.

Color in alcohol pale brown below, darker above, and each series of scales longitudinally with a narrow dark band. A broad brassy band, as wide as pupil, more or less olivaceous along its upper margin, extending from pectoral to base of caudal. A pale median olivaceous streak from occiput to first dorsal, and continued posteriorly to base of caudal. Lower surface of head brassy. Fins more or less uniform pale brown. Peritoneum black.

Length $8\frac{1}{8}$ inches.

One example, identified as *Atherina laticlavia* by Cope. Callao Bay. Peru. Prof. James Orton. Presented by Prof. E. D. Cope. Dr. Smitt has recently figured an example identified as *Atherinichthys regia* var. *laticlavia*.[2] However, it shows about 70 scales in a lateral count to base of caudal. *Basilichthys microlepidotus* is also united with *regia*.

[2] *Bih. Kon. Sven. Vet.-Ak. Hand. Stockholm*, XXIV, iv., 1899, p. 31, Pl. 4, fig. 30.

THYRINA Jordan and Culver.

Contr. Hopkins Lab. Biol., I, 1895, p. 419 (*evermanni*).

Thyrina guatemalensis (Günther). Plate XLIII (lower figure).

Atherinichthys guatemalensis Günther, Proc. Zool. Soc. Lond., 1864, p. 151. Lakes of Huamuchal. (Mr. Salvin.)——Günther, Trans. Zool. Soc. Lond., 1868, p. 443. [Same examples.]
Chirostoma guatemalensis Gill and Bransford, Proc. Acad. Nat. Sci. Phila., 1877, p. 187. Lake Nicaragua. [No description.]
Menidia guatemalensis Jordan and Evermann, Bull. U. S. Nat. Mus. (Fish N. Mid. Amer.) No. 47, I, 1896, p. 801. [Copied.]
Thyrina guatemalensis Jordan and Evermann, Rep. U. S. Fish Com., 1896, p. 332. [Reference.]

Head 4⅕; depth 4½; D. IV–I, 9; A. I, 22; P. I, I, 12; V. I, 5; scales 40 to base of caudal; 27 before spinous dorsal; 8 in transverse series between origin of anal and spinous dorsal; width of head 1⅞ in its length; depth of head 1½; snout 3⅗; eye 2⅔; maxillary 3; mandible 3; interorbital space 3¼; length of spinous dorsal 3; first dorsal ray 2; first anal ray 1⅓; pectoral 1; ventral 2; least depth of caudal peduncle 2¾; length of base of anal a little less than ⅓ of length of body.

Body elongate, strongly compressed, greatest depth at origin of anal, and lower profile forming obtuse angle at this point. Upper profile evenly convex. Abdomen strongly compressed, and edge not sharp or trenchant, but rather narrowly convex. Greatest width of trunk a little less than that of head, and found at bases of pectorals.

Head elongate, conic, rather obtuse in front, sides compressed and constricted below. Snout broad, and flattened above. Eye large, anterior, and close to upper profile. Mouth small, oblique, and superiorly terminal. Jaws nearly equal when closed, and premaxillaries protractile. Maxillary slender, and reaching posteriorly below front edge of eye. Teeth rather large, conic, sharp-pointed, and biserial in jaws. No teeth on vomer and palatines. Tongue small, rather narrow, and free in front. Each ramus of mandible elevated inside of mouth. Lips thin. Anterior nostrils lateral, about midway between tip of snout and orbit, posterior above front rim of orbit. Interorbital space flat. Top of head posterior to eyes, convex. Top of snout somewhat cavernous.

Gill-opening extending forward about opposite first ⅖ of eye. Rakers long, slender, and numerous. Filaments numerous, and long. No pseudobranchiæ. Isthmus narrow, constricted and trenchant.

Scales large, rather thin, cycloid, with uneven margins, and somewhat imbricated on side of trunk. Scales of head extending on interorbital space where they become enlarged. Single row of large scales on cheek. Scales on sides of head above, large. Snout and jaws naked.

No pectoral flap. Ventrals with rather broad scales between bases, and each with short basal scaly flap.

Origin of spinous dorsal well behind that of anal, or much nearer tip of snout than tip of caudal, small, spines weak, and when depressed reaching nearly $\frac{2}{3}$ of distance to soft dorsal. Soft dorsal inserted a little nearer base of caudal than origin of ventral, first ray undivided and longest. Anal inserted a little nearer base of caudal than tip of snout, base long, and base of last ray distant from base of caudal more than half of length of base of fin itself. Extending posteriorly beyond base of last dorsal ray, anterior rays elongate and first longest. Caudal rather long, emarginate, and both lobes apparently sharp-pointed. Pectoral long, falcate, sharp-pointed, and falling a little short of tip of ventral. Ventral small, united posteriorly, and reaching almost to origin of anal. Anus placed a little before tips of ventrals.

Color in alcohol pale straw-brown. A few of scales along dorsal surface sprinkled with brown dots. Lower surface more or less pale silvery. A broad silvery-lead-colored band as wide as pupil extending from axil of pectoral to base of caudal. Upper edge of band more or less dark. Dorsal and caudal grayish-brown. Peritoneum brownish.

Length $2\frac{3}{16}$ inches.

One example. Nicaragua. Dr. J. F. Bransford. Probably one of the examples recorded by Drs. Gill and Bransford.

Subfamily **Atherinopsinæ.**

Premaxillaries not freely protractile, the skin continuous mesially with forehead.

PROTISTIUS Cope.

Proc. Acad. Nat. Sci. Phila., 1874, p. 66 (*semotilus*).

Teeth simple, pointed, in bands in jaws, and also present on vomer. A single small dorsal spine.

This genus was first provisionally referred to the *Mugilidæ* by Cope, which was certainly in better propinquity than his final attempt to merge it in the "*Cyprinodontidæ.*"

Protistius semotilus Cope. Plate XLIV.

L.c. Some portion of the Peruvian Andes, from an elevation of twelve thousand feet.

Head 4; depth about 5; D. I–I, 10; A. I, 13; P. I, I, 15; V. I, 5; about 75 scales to base of caudal in lateral series; width of head $1\frac{7}{8}$ in its length; snout 3; eye about 5; maxillary about $2\frac{7}{8}$; interorbital space $2\frac{2}{3}$; pectoral $1\frac{2}{7}$; ventral 2; least depth of caudal peduncle $2\frac{3}{5}$. Snout projecting a little beyond mandible. Teeth rather elongate,

pointed, and a small patch present on vomer. Tongue small, and not free from floor of mouth. Nostrils well separated. Gill-opening extending forward nearly opposite front rim of orbit. Rakers slender, rather numerous, and shorter than filaments. Isthmus trenchant, narrow. Middle of base of pectoral about opposite lower rim of orbit. Anal beginning a little in front of second dorsal. Anus close in front of anal. Peritoneum blackish.

Length 5½ inches.

Type of *Protistius semotilus* Cope, No. 14,404, A. N. S. P. Peruvian Andes, from an elevation of twelve thousand feet.

GASTEROPTERUS Cope.

Proc. Amer. Philos. Soc., XVII, 1878, p. 700 (*archæus*).
Pisciregia J. F. Abbott, Proc. Acad. Nat. Sci. Phila., 1899, p. 342 (*beardsleei*).

Differs from *Protistius* chiefly in the presence of more than one dorsal spine.

Originally confounded with the *Mugilidæ* by Prof. Cope, this genus has recently been redescribed by Mr. J. F. Abbott under the name of *Pisciregia*.

Gasteropterus archæus Cope. Plate XLIII (upper figure).

L.c. At Arequipa, on the Pacific slope, at an elevation of 7,500 feet. [Peru.] (Coll. Prof. James Orton.)

Head 4; depth about 6; D. IV–I, 11; A. I, 15; P. I, I, 16; V. I, 5; scales about 86 in lateral series to base of caudal; width of head 2 in its length; snout 3⅓; eye about 5; maxillary about 2⅞; interorbital space 2⅞; pectoral 1⅓; ventral a little over 2; least depth of caudal peduncle 2⅞. Snout protruding a little beyond mandible. Tongue small, rather narrow, and a little free in front. Nostrils well separated. Gill-opening extending forward nearly opposite front rim of pupil. Rakers shorter than filaments, slender, and rather numerous. Pseudobranchiæ rather small. Isthmus narrow and compressed. Several irregular lateral series of porous or tubular scales, and though lower is broken in places it is more complete than others. Pectoral extends a little more than ¾ of distance to base of ventral. Anus about midway between tip of ventral and origin of anal. Peritoneum deep brown.

Length 6½ inches.

Type of *Gasteropterus archæus* Cope, No. 22,002, A. N. S. P. Arequipa on the Pacific slope at an elevation of 7,500 feet. Peru. Prof. James Orton, collection of 1874. Prof. E. D. Cope. Also a co-type with same data.

Pisciregia beardsleei J. F. Abbott is closely related, if distinct, and while included in Mr. Abbott's paper on "The Marine Fishes of Peru"

as evidently having been obtained at Callao, could it not have been brought there from the neighboring mountains? There is little to distinguish it in the original account from *G. archæus*, still it may be a salt-water representative.

ATHERINOPSIS Girard.

Proc. Acad. Nat. Sci. Phila., 1854, p. 134 (*californiensis*).

Atherinopsis californiensis Girard.

L.c., San Francisco, Cal. (Dr. A. L. Heermann.)
Atherinichthys californiensis Günther, Cat. Fish. Brit. Mus., III, 1861, p. 406. [Copied.]
Chirostoma californiense Jordan and Gilbert, Proc. U. S. Nat. Mus., III, 1880, p. 29. San Diego, California.
Atherina storeri Ayres, in Girard, *l.c.*, 1856, p. 136.

Head $4\frac{1}{2}$; depth $5\frac{1}{2}$; D. IX–I, 12; A. I, 22; P. I, 16; V. I, 5; scales about 73 in lateral series to base of caudal (squamation injured); 51 before spinous dorsal; about 15 in oblique transverse series between origins of soft dorsal and anal; width of head $2\frac{1}{8}$ in its length; depth of head $1\frac{3}{4}$; snout $3\frac{1}{8}$; eye $4\frac{7}{8}$; tip of upper jaw to corner of mouth 5; to end of maxillary $3\frac{2}{5}$; interorbital space $3\frac{2}{5}$; length of depressed dorsal $2\frac{2}{5}$; base of soft dorsal 2; base of anal 1; pectoral $1\frac{1}{10}$; ventral $2\frac{1}{3}$; least depth of caudal peduncle $3\frac{1}{3}$; length of caudal peduncle from base of last dorsal ray $1\frac{3}{7}$.

Body elongate, well compressed, fusiform, and greatest depth a little before origin of ventral. Sides slightly convex. Caudal peduncle elongate, strongly compressed, and least depth close to base of caudal. Head elongate, pointed, compressed, greatest width in middle of postocular region, and also equal to greatest width of trunk at bases of pectorals. Side of head more or less flattened, becoming conspicuously constricted below eyes. Snout broad, jaws produced, so that upper is bluntly pointed when viewed from above. Eye high, not impinging on upper profile, and posterior rim a little posterior to middle of head. Eyelid somewhat thick and adipose-like. Mouth high, nearly horizontal and upper jaw slightly longer than lower. Posteriorly gape of mouth turns obliquely down. Premaxillaries not protractile or with a distinct frenum above separating them from snout. Maxillary narrow, its distal expanded portion about half of pupil, oblique, upper portion more or less concealed below preorbital, and falling well short of front orbital rim. Articulation of mandible with quadrate nearly opposite front rim of orbit, and expanded somewhat in front till equal to orbit. Each ramus of mandible high and well elevated inside of mouth. Teeth in jaws small, pointed, and bi-

serial. No vomerine or palatine teeth. Tongue small, elongate, and free in front. Anterior nostril circular, nearly midway between tip of upper jaw and front of eye. Posterior nostril well separated, slit-like, in advance of front of orbit. Interorbital space broad, and slightly conic. Top of head posterior to eyes conic.

Gill-opening large, extending forward till nearly opposite front rim of orbit. Rakers long, slender, compressed, 7+37 on first arch, and longest about $\frac{4}{5}$ of longest filaments. Filaments numerous and long. Pseudobranchiæ absent. Isthmus long narrow and branchiostegal membranes not united.

Scales small, cycloid, somewhat imbricated, and with uneven edges. About six rows on cheek, and first three small and close to eye. With exception of snout, jaws and space in front of eye, head scaled. No scaly flaps except small one between bases of ventrals.

Spinous dorsal in groove, weak, and inserted a little nearer tip of snout than tip of caudal. Soft dorsal small, inserted a little nearer base of caudal than origin of ventral, or nearly over middle of base of anal. Like anal rays, anterior highest. Anal begins about opposite tip of depressed dorsal or a little nearer base of caudal than origin of pectoral. Caudal forked, lobes pointed. Pectoral high, broad at base, and falcate tips not reaching base of ventral. Ventral small, pointed, and not reaching opposite origin of spinous dorsal. Anus remote from ventrals, near front of anal.

Color in alcohol dull brown, paler beneath, and all more or less brassy. An indistinct longitudinal band about as wide as eye from base of pectoral to base of caudal. Fins plain uniform brown. Peritoneum black.

Length $7\frac{1}{2}$ inches.

Type of *Atherinopsis californiensis* Girard, No. 10,208, A. N. S. P. San Francisco, California. Dr. A. L. Heermann.

Two co-types with same data, also other material from Monterey Bay and San Diego, has been compared.

Atherinops magdalenæ sp. nov. Plate XLII (lower figure).

Head $4\frac{1}{2}$; depth 5; D. V–I, 10; A. I. 22; P. I, 14; V. I, 5; scales 47 in a lateral series to base of caudal; 10 scales obliquely back from spinous dorsal to base of anal in front; width of head $2\frac{1}{5}$ in its length; depth of head $1\frac{3}{5}$; snout $3\frac{1}{3}$; eye 4; maxillary $3\frac{1}{8}$; interorbital space $3\frac{1}{4}$; pectoral a little shorter than head; ventral 2; least depth of caudal peduncle $2\frac{1}{2}$.

Body well compressed, lower profile more convex than upper, and

greatest depth about midway in its length. Caudal peduncle compressed, its least depth a little less than half its length.

Head rather small, compressed, more or less constricted below, upper profile nearly straight, and lower well curved convexly. Snout long. Eye moderate, high, circular and anterior. Mouth horizontal, jaws subequal or lower only slightly projecting. Upper jaw broad and depressed. Teeth uniserial, bicuspid, and rather small in jaws. No teeth on vomer. Tongue small, far down and little free in mouth. Each ramus of mandible well elevated inside of mouth. Maxillary slender, vertically inclined, and falling little short of front rim of orbit. Nostrils well separated. Interorbital space rather broad and slightly convex.

Gill-opening extending forward about opposite front rim of pupil. Rakers slender, rather numerous, and shorter than filaments. No pseudobranchiæ. Isthmus narrow, trenchant.

Scales of moderate size, cycloid, and hardly imbricated, those on chest smaller and crowded. Head scaly, about three rows on cheek. Bases of soft dorsal and anal with scaly sheaths. Base of caudal with small scales. Several irregular or broken series of tubes on side of body representing lateral system, lowest most perfect.

Spinous dorsal inserted a little behind anus, small, much lower than soft dorsal and second spine apparently largest. Soft dorsal low, anterior rays highest, and inserted a little before middle of base of anal. Anal large, similar in shape to soft dorsal and beginning close behind anus. Caudal damaged, evidently emarginate. Pectoral rather long, reaching past base of ventral, and first rays longest. Ventral rather small. Anus nearly midway between tip of depressed ventral and origin of anal, at least distinctly before origin of spinous dorsal.

Color in alcohol dull brown, back a little darker. A broad silvery lateral band equal to $\frac{3}{4}$ eye-diameter, and upper half grayish. Sides of head with silvery reflections. Fins plain brownish. Orbit brassy. Peritoneum silvery-gray.

Length (caudal damaged) $3\frac{1}{2}$ inches.

Type No. 10,206, A. N. S. P. Magdalena Bay, Lower California. W. N. Lockington. Two examples, inclusive of type.

This species appears to be a southern representative of *Atherinops affinis* (Ayres), differing in the anterior position of the vent.

(Named for Magdalena Bay, Lower California.)

Explanation of Plates XLI–XLIV.

Plate XLI.—*Atherina sardinella* Fowler.
Type No. 15,397, A. N. S. P. Italy.
Phoxargyrea dayi Fowler.
Type No. 10,177, A. N. S. P. India.

Plate XLII.—*Ischnomembras gabunensis* Fowler.
Type No. 14,934, A. N. S. P. West Africa.
Atherinops magdalenæ Fowler.
Type No. 10,206, A. N. S. P. Lower California.

Plate XLIII.—*Gasteropterus archæus* Cope.
Type No. 22,002, A. N. S. P. Peru.
Thyrina guatemalensis (Günther).
No. 15,983, A. N. S. P. Nicaragua.

Plate XLIV.—*Protistius semotilus* Cope.
Type No. 14,404, A. N. S. P. Peru.

NEW AND LITTLE KNOWN MUGILIDÆ AND SPHYRÆNIDÆ.

BY HENRY W. FOWLER.

All of the material on which the present paper is based is in the Museum of the Academy of Natural Sciences of Philadelphia.

MUGILIDÆ.

Mugil brasiliensis Spix.

Sel. Gen. Spec. Pisc. Brasil, 1829, p. 72. Oceano Atlantico. (Museo Monacensi.)

Head 4; depth $4\frac{1}{3}$; D. IV–I, 8; A. III, 8; scales 33 in lateral series to base of caudal; snout 4 in head; eye $4\frac{1}{3}$; interorbital space $2\frac{1}{6}$. Mandibular angle obtuse. Ciliiform teeth in both jaws. Scales large, those on caudal peduncle and below soft dorsal but little smaller than others on middle of side. Soft dorsal and anal with small scales on basal portions of membranes of anterior rays. Soft dorsal inserted a little behind origin of anal. Pectoral falling short of origin of spinous dorsal by about $\frac{1}{3}$ its own length. Length $8\frac{3}{4}$ inches. Rio Janeiro, Brazil. Dr. Turner. Other examples from Surinam and St. Martin's, W. I., have been compared and found to agree.

Mugil cephalus Linnæus.

Syst. Nat., Ed. X, 1758, p. 316. Oceano Europæo.

Examples from Florida, Ft. Macon (N. C.), South Carolina, Wood's Hole (Massachusetts), ?Montevideo (Uruguay), Peru and Beirut (Syria), agree. The only differences are due apparently to age or individual variation.

Mugil kelaartii Günther.

Cat. Fish. Brit. Mus., III, 1861, p. 429. Point de Galle. (Sir A. Smith.) Philippine Islands.——Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p. 500. Sandwich Islands. (Dr. Wm. H. Jones.)

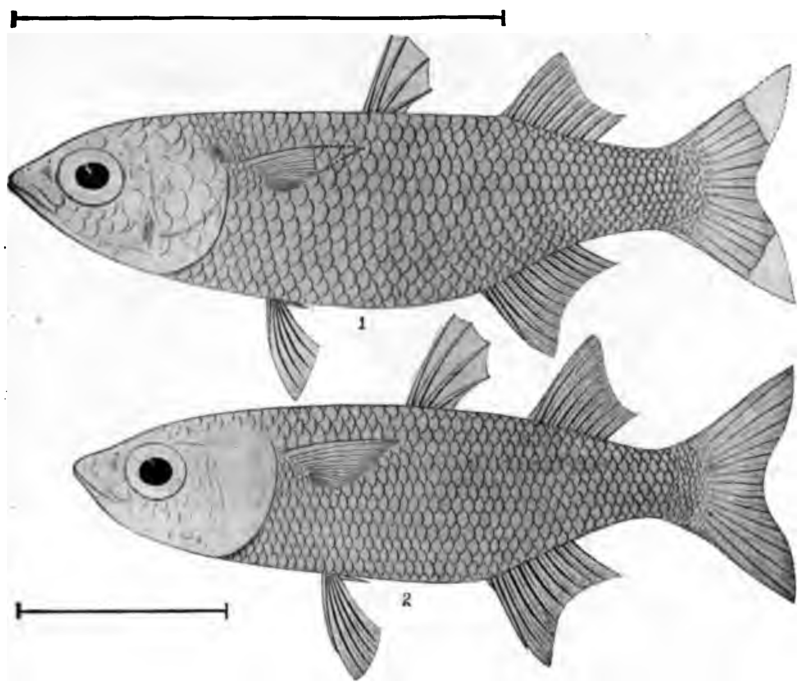
Head $3\frac{7}{8}$ ($3\frac{3}{4}$); depth $3\frac{9}{10}$ ($3\frac{2}{3}$); D. IV[1]–I, 8; A. III, 9; scales 31 in a lateral series to base of caudal; snout 4 in head; eye 4; interorbital space $2\frac{1}{2}$; pectoral $1\frac{1}{10}$. Only a small portion of base of soft anal, about $\frac{1}{6}$ in advance of that of soft dorsal. In smaller example about $\frac{1}{3}$ of soft anal in advance of soft dorsal. Mandibulary angle a little obtuse. Spinous dorsal inserted a little nearer base of caudal than tip of snout. Scales large, those on snout not extending to its margin and little reduced in size. Soft dorsal and anal covered with small scales

[1] Spines not VI as given in notes.

on their basal portions, mostly on membranes between rays. Length $7\frac{11}{16}$ inches. Two examples.

Hawaiian Islands. Dr. William H. Jones.

They both appear identical with *M. kelaartii*, agreeing largely with Dr. Günther's account and figure.[2]



Querimana stages of (1) *Mugil cephalus*, and (2) *Mugil curema*.

Mugil curema Valenciennes.

Hist. Nat. Poiss., XI, 1836, p. 64. Brésil. Martinique. (M. Plée.) Cuba. (M. Choris.) Bahia.

Examples are before me from Wood's Hole (Massachusetts), Beach Haven and Beasley's Point (New Jersey), Ft. Macon (N. C.), mouth of St. Lucie river (Florida) and San Domingo, West Indies. Latter from Prof. W. M. Gabb, containing an example in the *Querimana* stage.

Mugil incilis Hancock. Plate XLV (lower figure).

Quart. Jour. Sci. Lit. Art. London, 1830, p. 127. In the trenches or ditches dug for draining the flat lands of the coast of Guiana. (Museum of the Zoölogical Society [of London].)

Head $3\frac{5}{6}$; depth 4; D. IV-I, 8; A. III, 9; P. II, 14; V. I, 5; scales

[2] *Journ. Mus. Godef.*, XI, VI, 1877, p. 215. Otaheiti. (Museum von Raiatea.) ——*L.c.*, XV, VII, 1878, Pl. 121, fig. *a*.

42 in a lateral series to base of caudal; about 15 scales in an oblique series from origin of spinous dorsal to middle of belly; 24 scales before spinous dorsal; width of head $1\frac{2}{3}$ in its length; depth of head $1\frac{1}{3}$; snout 4; eye $3\frac{1}{3}$; maxillary $3\frac{1}{3}$; interorbital space $2\frac{1}{2}$; second dorsal spine $1\frac{2}{3}$; first dorsal ray 2; third anal spine $2\frac{2}{3}$; upper caudal lobe $1\frac{1}{8}$; least depth of caudal peduncle $2\frac{1}{3}$; pectoral $1\frac{1}{3}$; ventral $1\frac{1}{2}$.

Body fusiform, compressed, greatest depth about middle of length and profiles more or less evenly convex. Caudal peduncle compressed, and its least depth about $1\frac{2}{5}$ in its length.

Head robust, a little constricted below, and profiles evenly convex. Snout broad, a little convex above, and upper jaw hardly produced. Eye anterior with well developed adipose eyelids. Mouth a little inferior, corner not quite reaching opposite anterior rim of orbit. Mandibular angle a right one, and symphysis form a process that fits in a depression of upper jaw. Teeth rather large, uniserial, ciliiform, and present in both jaws. Tongue fleshy, not free. Maxillary exposed, and reaching opposite front rim of orbit. Lower edge of preorbital denticulate. Anterior nostril with a small cutaneous rim, near edge of snout, and space between it and posterior much greater than space between latter and front of eye. Posterior nostril rather large. Interorbital space broad and slightly convex.

Gill-opening extending forward till about opposite middle of orbit. Rakers about 50?, slender, fine, equal to about $\frac{3}{4}$ length of longest filaments, which are numerous and also equal to about $\frac{3}{4}$ of orbital diameter. Pseudobranchiæ about half of orbital diameter. Isthmus narrow, with a groove.

Stomach gizzard-like, muscular, and about size of eye. Intestine long, with many convolutions. Peritoneum blackish. Anus close in front of anal fin.

Scales a little small, and in more or less even longitudinal series. Head scaly. Scales extending down along edge of snout small. A slender pointed scaly flap along base of spinous dorsal about equal in length to $\frac{3}{5}$ length of first spine. Scaly flap at axil of pectoral a little less than half length that of fin. Ventral with a similar scaly flap, and a median one between bases of each of these fins about $\frac{2}{3}$ their length. Greater portions of soft dorsal, anal, and caudal covered with minute scales, those at their bases larger.

Spinous dorsal inserted a little nearer tip of snout than base of caudal, second spine longest, and fourth shortest. Soft dorsal inserted nearer origin of spinous than base of caudal, and first ray longest, margin of fin a little concave. Anal similar to soft dorsal, spines slender, grad-

uated to third which is longest, first much shortest, and origin of fin nearly opposite tip of depressed spinous dorsal. Caudal forked, lobes pointed and angular, when expanded emarginate. Pectoral small, reaching origin of spinous dorsal and its origin level with upper margin of orbit. Ventral inserted a little before middle of pectoral, its spine about $\frac{2}{3}$ length of fin.

Color in alcohol brownish, back and upper surface deep dull olivaceous-brown. A dusky blotch at base of pectoral. No dark streaks present along series of scales. Fins pale, dorsals and caudal a trifle darker.

Length $4\frac{5}{8}$ inches.

One example. Paramaribo, Surinam. Dr. Hering. Also fourteen others with same data.

Mugil güntheri Steindachner is said to have 46 or 47 scales in a lateral series to the base of the caudal. I am unable to count more than 4[illegible] scales in any of the above examples.

LIZA Jordan and Swain.

Proc. U. S. Nat. Mus., VII, 1884, p. 261 (*capito* = *ramada*).

Subgenus LIZA Jordan and Swain.[3]

Type *Mugil ramada* Risso.

Upper lip thin, not enlarged.

Liza cascasia (Hamilton).

Mugil cascasia Hamilton, Acc. Fish. Ganges, 1822, pp. 217, 380. Northern rivers of Bengal.

One example from the Ganges river, India.

Liza alosoides sp. nov. Plate XLV (upper figure).

Head $3\frac{1}{3}$; depth $3\frac{1}{6}$; D. IV–I, 8; A. III, 9; P. II, 15; V. I, 5; scales 38 in a lateral series to base of caudal (squamation injured); about 13? scales in an oblique transverse series back from origin of spinous dorsal; 18 scales before spinous dorsal; width of head $1\frac{7}{8}$ in its length; depth of head $1\frac{1}{4}$; snout $4\frac{1}{2}$; eye $3\frac{1}{2}$; maxillary $3\frac{1}{3}$; interorbital space $2\frac{7}{8}$; first dorsal spine 2; first branched dorsal ray $1\frac{9}{10}$; third anal spine $2\frac{1}{2}$; first anal ray $1\frac{3}{4}$; pectoral $1\frac{1}{2}$; ventral $1\frac{5}{6}$; least depth of caudal peduncle $2\frac{1}{3}$.

Body rather deep, well compressed, greatest depth about median, and profiles evenly and similarly convex. Caudal peduncle compressed, its least depth about equal to its length.

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[3] Other species examined are *Liza ramada* (Risso), *Liza aurita* (Risso), and *Liza saliens* (Risso).

Head deep, well compressed, and becoming more or less constricted below. Snout rather broad, and convex, upper jaw projecting a little. Eye anterior, without adipose lids. Maxillary reaching front margin of orbit, and partially exposed. Mandible, with rami forming a right angle, exposed median strip on chin rather broad. Teeth ciliiform, uniserial, and rather long in jaw. Symphysis with usual process. Tongue not free, fleshy. Preorbital finely serrate. Nostrils well separated, posterior closer to upper front rim of orbit than to anterior. Interorbital space broad, and a little convex.

Gill-opening extending forward till opposite middle of eye. Gill-rakers numerous, fine, slender, shorter than filaments which are about $\frac{3}{4}$ of eye. Pseudobranchiæ about half of orbital diameter.

Stomach gizzard-like, muscular. Intestine long, with many convolutions. Peritoneum dark brown.

Scales moderately large. A long, pointed, scaly flap at base of spinous dorsal and another between bases of ventrals. Soft dorsal and anal covered with small scales over their greater portions. Base of caudal scaly.

Spinous dorsal inserted nearer base of caudal than tip of snout, and second spine a trifle longest. Soft dorsal inserted nearly midway between origin of spinous dorsal and base of caudal. A little less than half of base of anal inserted before origin of soft dorsal, third spine longest, second but little shorter, and first short. Caudal emarginate, lobes pointed and producing a forked appearance when fin is not expanded. Pectoral inserted a little above upper rim of orbit, and falling about opposite origin of spinous dorsal. Ventral inserted about opposite middle of pectoral, and spine nearly $\frac{2}{3}$ length of fin.

Color in alcohol pale brown, back slightly darker, and tinged with dull olivaceous. No traces of streaks on side. Base of pectoral scarcely darker than rest of fin. Fins all plain pale brownish.

Length 3 inches.

Type No. 9,771. Gabun country, West Africa. P. B. DuChaillu.

Six co-types, also with same data. They seem probably related to *Liza schlegeli* (Bleeker),[4] but that species is said to have but 30 scales in a lateral series.

(*Alosa*, old name of the European shad; εἶδος, resemblance.)

Liza caldwelli (Fowler).

Mugil caldwelli Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p. 524, Pl. 19, fig. 4. Samoa. (Dr. H. C. Caldwell.)

Head $3\frac{4}{7}$; depth $3\frac{3}{4}$; D. IV–5; A. III, 9; P. II, 14. Eyelid narrow,

[4] *Nat. Verh. Holl. Maats. Wet. Haarlem*, XVIII, 1863, p. 92, Pl. 19, fig. 1. Guinea (Ashantee).

though adipose-like, but not infringing on iris. Jaws edentulous. Corner of mouth reaching opposite anterior nostril, not "a trifle posterior to the posterior nostrils," but extremity of maxillary extending a trifle beyond posterior nostril. Strip on chin between rami of mandible narrow. Stomach gizzard-like and muscular. Intestine long, with many convolutions. Peritoneum blackish.

One example. Type of *Mugil caldwelli* Fowler, No. 9,841, A. N. S. P. Samoa. Dr. H. C. Caldwell.

OEDALECHILUS subgen. nov.[5]

Type *Mugil labeo* Cuvier.

Upper lip thick.

(*Οἰδαλέος*, swollen; *χεῖλος*, lip.)

Agonostomus monticola (Griffith).

> *Mugil monticola* Bancroft, in Griffith, Anim. Kingd. Cuv., X, 1834. Jamaica. (Dr. Bancroft.)

Head $3\frac{2}{7}$; depth $3\frac{1}{3}$; D. IV–I, 8; A. III, 9; scales 41 in lateral series to base of caudal; width of head $1\frac{9}{10}$ in its length; snout $3\frac{1}{3}$; eye 5; maxillary $2\frac{1}{2}$; interorbital space 3; first dorsal spine $2\frac{1}{10}$; pectoral $1\frac{3}{7}$; ventral $1\frac{5}{7}$; least depth of caudal peduncle $2\frac{4}{5}$. Maxillary reaching middle of eye. Soft dorsal and anal marked by a longitudinal or transverse dusky bar. Length 9 inches. Eighteen examples from San Domingo, West Indies. Prof. W. M. Gabb. Young examples show a slightly convex interorbital space, and maxillary reaches a little past front of eye.

In the original account of *Agonostoma percoides* I am unable to construe the account of the interorbital space.[6] The construction of the sentence does not seem to leave it clear that the interorbital space is $\frac{1}{3}$ the length of head. Besides agreeing in most respects with my San Domingo material, all of the examples mentioned are either half-grown or adults. It is possible, therefore, that *percoides* may be identical with *monticola*. The length of the adult example examined by Dr. Günther is not stated.

Joturus pichardi Poey.

> Mem. Hist. Nat. Cuba, II, XLIX, 1856–58, p. 263, Pl. 18, figs. 4–5. Ce poisson se trouve dans toute l'île, dans les rivières quiont des cascades. [Cuba.]

Head $4\frac{1}{4}$; depth $3\frac{2}{5}$; D. IV–I, 9; A. III, 10; scales 44 to base of caudal in lateral series; width of head $1\frac{4}{7}$ in its length; snout $2\frac{3}{4}$; eye

[5] Species examined are *Liza provensalis* (Risso), and *Liza labeo* (Cuvier).
[6] *Cat. Fish. Brit. Mus.*, III, 1861, p. 465.

$6\frac{1}{3}$; interorbital space $2\frac{1}{7}$; first dorsal spine $1\frac{2}{5}$; first developed anal ray $1\frac{1}{4}$; least depth of caudal peduncle $2\frac{1}{8}$; pectoral $1\frac{1}{6}$; ventral $1\frac{1}{3}$. Length 11 inches. One from eastern San Domingo, West Indies. Prof. W. M. Gabb.

SPHYRÆNIDÆ.

AGRIOPOSPHYRÆNA subgen. nov.

Type *Esox barracuda* Walbaum.

Scales 90 or less. Top of head broad, flat and interorbital space slightly concave. Lower margin of orbit midway or above middle of depth of head. Body rather robust.

(Ἀγριωπὸς, wild; Σφύραινα, Sphyræna.)

Sphyræna snodgrassi Jenkins.

Bull. U. S. Nat. Mus., 1899 (1901), p. 388, fig. 2. Honolulu. (Drs. O. P. Jenkins and T. D. Wood.)

Sphyræna commersoni Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p. 501. Sandwich Islands. (Dr. William H. Jones).——*L.c.*, p. 520. Tahiti. (Dr. J. K. Townsend.) (Not of Cuvier.)

Head 3; depth $5\frac{3}{4}$; D. V–I, 9; A. II, 8; scales 80 in lateral line to base of caudal, 8 more on latter; snout $2\frac{1}{5}$ in head, from its tip; eye 6; maxillary $2\frac{1}{4}$; interorbital space $4\frac{3}{4}$; pectoral $2\frac{3}{4}$; ventral 3; least depth of caudal peduncle 4. Eye a little longer than deep, and its lower margin about midway in depth of head. Distal extremity of maxillary not quite reaching front rim of orbit. Jaws forming rather robust or broad angle, lower not greatly produced. Edge of isthmus rounded. Interorbital space slightly concave. Dorsals and anal brown on greater portions distally, soft dorsal dark. Length $9\frac{1}{2}$ inches. Hawaiian Islands.

Head $2\frac{9}{10}$; depth about $6\frac{3}{4}$. End of maxillary a little short of front rim of orbit. Dark brown of vertical fins apparently faded. Tahiti.

Close to *S. barracuda* of the West Indies, apparently differing in the shorter maxillary, though I have not had the opportunity to compare examples of intermediate size.

Sphyræna barracuda (Walbaum).

Esox barracuda Walbaum, Pet. Art. Gen. Pisc., III, 1792, p. 94. (Based on *Barracuda* Catesby, Nat. Hist. Flor. Bah., II, 1771, p. 1, Pl. 1. In all the shallow seas of the Bahama Islands.)

Two examples from San Domingo, West Indies. Prof. W. M. Gabb. A Porto Rican example, in alcohol, shows ten large brown blotches on side and vertical fins with dusky.

Subgenus SPHYRÆNA Schneider.

Scales small, 100 or more. Top of head rather narrow, usually slightly convex. Lower margin of orbit usually below middle of depth of head. Body rather slender.

Sphyræna ensis Jordan and Gilbert.

Bull. U. S. Fish Com., II, 1882, p. 106. Mazatlan, Mexico. (Charles H. Gilbert.)

Head 3, from tip of mandible; depth $7\frac{1}{2}$; D. V–I, 9; A. II, 8; scales about 108 in lateral line to base of caudal, 8 more continued on latter; snout $2\frac{1}{4}$ in head, from its tip; eye $5\frac{1}{2}$; maxillary $2\frac{1}{4}$; interorbital space $5\frac{4}{7}$; pectoral about $2\frac{2}{3}$. Head slender, jaws attenuate. Eye low, lower margin $\frac{3}{5}$ in depth of head. Interorbital space a little elevated convexly, two median ridges pronounced. Maxillary reaching front margin of eye. Mandible with fleshy tip. Gill-rakers better developed than in *guachancho*, short, numerous, pointed, rather firm. Pectoral reaching well beyond spinous dorsal. Spinous dorsal dusky. Length $17\frac{1}{8}$ inches. One example from Panama. J. A. McNeil.

Sphyræna picudilla Poey. Plate XLVI (lower figure).

Mem. Hist. Nat. Cuba, II, 1856–58, p. 162. Havane.

Head $2\frac{9}{10}$ from tip of snout; depth $8\frac{3}{4}$; D. V–I, 9; A. II, 9; P. I, 12; V. I, 5; scales 110 in lateral line to base of caudal, 5 more on latter; width of head 4 in its length, from tip of mandibles; depth of head $3\frac{1}{4}$; first dorsal spine $3\frac{1}{4}$; pectoral 3; ventral $3\frac{1}{3}$; least depth of caudal peduncle $5\frac{7}{8}$; snout $2\frac{1}{4}$ in head, from its own tip; eye 6; maxillary $2\frac{2}{3}$; interorbital space $5\frac{1}{2}$. Caudal peduncle stout, compressed, its least depth about $2\frac{3}{5}$ in its length. Mandible with somewhat fleshy tip. First dorsal spine longest, though little longer than second. Pectoral not reaching opposite origin of spinous dorsal. Tip of lower jaw pale, though a little dusky above. Otherwise like *tome*. Length about $8\frac{1}{3}$ inches. One example. "Sambaia" (Brazil?). Mus. Comp. Zool.

Sphyræna borealis De Kay.

Zool. New York, IV, Fish., 1842, p. 39, Pl. 60, fig. 196. Harbor of New York.

Head $3\frac{1}{10}$; depth 8; D. V–I, 9; A. II, 9; scales 121 in lateral line to base of caudal, and about 5 more on latter; eye $5\frac{4}{5}$ in head, from tip of snout; maxillary $2\frac{2}{3}$. One example $15\frac{1}{2}$ inches long, from San Domingo, West Indies. Prof. W. M. Gabb.

Sphyræna tome sp. nov. Plate XLVI (upper figure).

Head 3, measured from tip of mandible; depth 8; D. V–I, 9; A. II, 8; P. I, 12; V. I, 5; scales 135 in lateral line to base of caudal, and

several (5?) more on latter; 24? scales in a transverse oblique series between origin of spinous dorsal and that of ventral; width of head 4 in its length; depth of head $3\frac{1}{5}$; mandible $1\frac{3}{4}$; second dorsal spine $3\frac{1}{4}$; least depth of caudal peduncle 6; ventral $3\frac{2}{5}$; snout $2\frac{1}{4}$ in head, measured from tip of upper jaw; eye 6; maxillary $2\frac{2}{3}$; interorbital space 7.

Body rather slender, not especially elongate, not especially compressed, but more or less cylindrical. Caudal peduncle compressed, its least depth about $3\frac{1}{8}$ in its length.

Head elongate, slender, attenuate, somewhat compressed, and becoming a little constricted below. Profiles similar, and nearly straight. Snout long, slightly convex above, with two frontal ridges, approximated at first, then more distant posteriorly, and continued well up to top of head behind eyes. Eye moderately large, orbicular and its lower margin about $\frac{2}{3}$ of distance in depth of head at that point. Maxillary falling far short of front of orbit, hardly reaching opposite posterior nostril. Distal expanded extremity of maxillary equal to about $\frac{2}{5}$ orbital diameter. Mandible produced well beyond upper jaw, and with a slightly fleshy tip. Teeth uniserial in jaws. Enlarged, compressed and fang-like below, and in sides of upper jaw short, fine, numerous and sharp-pointed. A single large fang at symphysis of mandible and four large canines in front of upper jaw. A single series of teeth on each palatine, consisting of several large compressed fangs in front, and giving place to small teeth, like those in upper jaw, posteriorly. Tongue long, slender, pointed, free mostly in front, and with its upper surface finely asperous. Lips rather broad and thin at corners of mouth. Nostrils rather near together, well in front of and about level with upper margin of eye. Interorbital space a little less than eye, and slightly elevated convexly.

Gill-opening extending forward till a little behind front rim of orbit. Rakers absent, replaced by minute asperities. Pseudobranchiæ a little shorter than filaments, which are a trifle less than half orbital diameter. Isthmus rounded.

Scales small. Head more or less covered with small scales, obsolete at present on opercle, where they may have fallen, and those on cheek small. Scales on trunk mostly fallen. Bases of soft dorsal, anal and caudal with small scales, especially first rays of former two fins. There they become minute and crowded. Lateral line straight, inclined from upper edge of gill-opening to middle of base of caudal, and consisting of rather large simple tubes. Scales mostly remain throughout its course.

Spinous dorsal inserted a trifle before origin of ventral, nearer tip

of snout than base of caudal, and spines rather pungent, second longest. Soft dorsal inserted midway between origin of spinous dorsal and base of caudal, anterior or first rays elevated, and highest. Anal similar, and its origin about opposite that of soft dorsal. Caudal emarginate. Pectoral small, damaged, though evidently falling well short of spinous dorsal. Ventral small, hardly reaching $\frac{2}{3}$ of distance to origin of anal. Anus close in front of anal fin.

Color in alcohol brown above, silvery-white below. Fins all pale brown, dorsals and caudal tinted a little with dusky. Tip of lower jaw blackish. Eye brassy. Peritoneum silvery.

Length (caudal damaged) 8½ inches.

Type No. 11,463, A. N. S. P. "Sambaia." Presented by the Mus. Comp. Zool., Cambridge, Massachusetts.

One example, the type. I am unable to locate the type locality, though subsequent labels refer it to Brazil. It was found in the same jar with *S. picudilla* and originally identified as *Sphyræna vulgaris*. It differs from *S. sphyræna* chiefly in fewer anal rays, and from *picudilla* in same way, though with more numerous scales in lateral line.

(*Τομή*, that cuts, acute.)

Explanation of Plates XLV and XLVI.

Plate XLV.—*Liza alosoides* Fowler.
Type No. 9,771, A. N. S. P. West Africa.
Mugil incilis Hancock.
No. 9,827, A. N. S. P. Guiana.

Plate XLVI.—*Sphyræna tome* Fowler.
Type No. 11,463, A. N. S. P. Sambaia
Sphyræna picudilla Poey.
No. 11,464, A. N. S. P. Sambaia.

NOVEMBER 17.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Nineteen persons present.

The Cause of Inverse Symmetry.—DR. EDWIN G. CONKLIN remarked that the fact that animals with totally inverse symmetry may occur within the limits of the same species indicates that the cause of this phenomenon must be an ontogenetic rather than a philogenetic one. Furthermore, in all cases in which the development of an inversely symmetrical animal has been studied, the cleavage of the egg is also found to be inverse. He had found that the inverse cleavage of Gasteropods may be traced back to the very first division of the egg, and that this must be preceded by an inverse organization of the unsegmented egg. No inverse organization can be detected in the ovarian eggs of sinistral snails, and it is therefore probable that it arises about the time of the maturation or fertilization of the egg. In dextral snails the polar bodies are formed at what was the free pole of the ovarian egg, and if the polar bodies were to be formed at the opposite or attached pole in sinistral forms it would entirely and satisfactorily explain their inverse symmetry. While such a reversal of the polarity of the egg in sinistral forms has not been demonstrated, certain observations have been made which render it probable.

The subject was discussed by Messrs. Chapman, Pilsbry and Skinner.

Morgan Hebard and Henry W. Fowler were elected members.

Hugo de Vries, of Amsterdam, Eduard Strasburger, of Bonn, and Nestor Grehant, of Paris, were elected correspondents.

The following were accepted for publication:

DESCRIPTION OF A NEW LANTERN FISH.

BY HENRY W. FOWLER.

MYCTOPHIDÆ.

CENTROBRANCHUS gen. nov.

Type *Centrobranchus chœrocephalus* sp. nov.

Close to *Rhinoscopelus* Lütken, but differing in the gill-rakers, which are short sparse clusters of asperities on the first arch.

(*Κέντρον*, prick; *βράγχος*, gill.)

Centrobranchus chœrocephalus sp. nov.

Rhinoscopelus coruscans Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p. 498. Near the Sandwich Islands. (Dr. William H. Jones.) (Not of Richardson.)

Rhinoscopelus oceanicus Jordan and Evermann, Bull. U. S. Fish Comm., 1902 (1903), p. 168. (Not description. Part.)

Head $3\frac{7}{8}$; depth 5; D. 10; A. 18; scales 35 in a lateral series to base of caudal; about 6 scales in a transverse series at origin of rayed dorsal; depth of head $1\frac{1}{5}$ in its length; width of head $2\frac{1}{3}$; snout $4\frac{1}{2}$; eye $3\frac{3}{4}$; interorbital space $3\frac{1}{2}$; maxillary $1\frac{3}{4}$; least depth of caudal peduncle 5.

Body elongate, well compressed, slender and tapering posteriorly, upper profile a little more convex anteriorly, and greatest depth about origin of ventral. Caudal peduncle long, slender, and its more or less even depth about $3\frac{1}{2}$ in length from adipose fin.

Head shaped somewhat like that of an Anchovy, upper profile a little more convex especially at occiput, and well compressed. Snout protruding beyond mouth, conic, and a little shorter than orbit. Eye small, circular, about midway in depth and near first third of head. Mouth large, inferior, maxillary narrow or slender, of even width, and extending posteriorly well beyond orbit. Mandibular rami formed of rather broad bones and extending far back like maxillary. Teeth in jaws and on palatines minute, and in narrow bands. Vomer with similar teeth, though a little more conspicuous. Tongue a short conic protuberance in front of mouth. Interorbital space convex. A slight mesial elevation in the internasal depression.

Gill-opening extending forward opposite middle of orbit. Rakers about 3+5 clusters or groups of small inconspicuous prickles on first arch. Filaments small. Pseudobranchiæ present. Isthmus narrow and trenchant.

Scales large, edges mostly entire, cycloid, stiff, and rather narrowly imbricated along middle of side. A few small scales on base of caudal, fins otherwise naked. Lateral line not evident.

Three mandibular photophores. One on lower anterior portion of opercle. An interorbital photophore. One at lower base of pectoral, and another just below along edge of gill-opening. Five thoracic. One anterolateral, above base of ventral. One mediolateral low, and just a little behind and above tip of ventral. Another apparently mediolateral, two scales behind and a little higher. Posterolateral inconspicuous, median in depth, and also about midway between dorsals over breach in anals. Ventrals four. Five anals, then a breach and finally four more. Six more continued along lower side of caudal peduncle without a breach, then two more. Two caudals below. One caudal above. Six large supercaudals, beginning just behind adipose fin.

Dorsal rather small, inserted nearer tip of snout than base of caudal, and posterior base opposite front of anal. Anal long, inserted nearly midway between posterior margin of pupil and base of caudal, anterior rays highest. Adipose dorsal small, a little before end of base of anal. Caudal small. Pectoral small, inserted a little below middle of depth of body. Ventral small, inserted near last third in space between origin of pectoral and that of dorsal.

Color in alcohol deep dusky with iridescent bluish, purplish and silvery reflections. Fins plain pale brownish. Photophores black, with bright silvery centers. Supercaudals with dull yellowish. Iris dull dark yellowish.

Length $1\frac{5}{16}$ inches.

Type No. 7,972, A. N. S. P. Near the Sandwich Islands. Dr. William H. Jones. Also three co-types with same data, and the smallest of these, together with the type, may probably be males as they are a little more attenuate than the others.

Originally I wrongly identified these examples with *Myctophum coruscans* Richardson. Drs. Jordan and Evermann consider them identical with their *Rhinoscopelus oceanicus*. If *oceanicus* is correct generically it is certainly distinct from the examples before me of *chærocephalus*. Examination of *R. coccoi*, typical of that genus, show that it has long, slender and numerous gill-rakers on the first arch. *R. oceanicus* would further differ in the large eye ($2\frac{1}{2}$ in head) and deeper body ($4\frac{1}{10}$ in length).

(*Χοῖρος*, pig; *κεφαλή*, head.)

A LIST OF SHELLS COLLECTED IN WESTERN FLORIDA AND HORN ISLAND, MISSISSIPPI.

BY E. G. VANATTA.

During February and March, 1902, Mr. Clarence B. Moore collected the following species of shells while on an archæological expedition in western Florida. Most of the specimens were picked up on the shore. The numbers after the species correspond to the numbers of the localities, as follows:

1. Alligator Harbor, Franklin county, Florida.
2. St. George's Sound, Franklin county, Florida.
3. Indian Pass, Apalachicola Bay, Calhoun county, Florida.
4. St. Joseph's Bay, Calhoun county, Florida.
5. Crooked Island, off St. Andrew's Sound, Calhoun county, Florida.
6. St. Andrew's Bay, Washington county, Florida.

Those numbered 7 are a collection of shells from Horn Island, Mississippi, presented to the Academy some years ago. It is hoped that this list, which well covers the western coast of non-peninsular Florida, will be a useful appendix to Prof. W. H. Dall's Bulletin 37 of the U. S. National Museum. I wish to thank Prof. W. H. Dall, Mr. C. W. Johnson and Dr. H. A. Pilsbry for their assistance in identifying some of the species of this collection.

Class PELECYPODA.

Ostrea virginica Gmel. 2, 4, 5.
Anomia simplex Orb. 4, 5, 7.
Plicatula gibbosa Lam. 4, 5, 7,
Pecten gibbus irradians Lam. 1, 3, 4, 5, 6, 7.
Atrina rigida Dillw. 4.
Atrina serrata "Sol." Sowb. 4.
Mytilus exustus L. 5.
Modiolus tulipus L. 1, 4, 5.
Modiolus demissus Dillw. 4.
Arca ponderosa Say. 1, 3, 4, 5, 7.
Arca transversa Say. 3, 5, 7.
Arca incongrua Say. 1, 3, 4, 7.
Arca campechiensis Gmel. 1, 3, 4, 7.
Arca secticostata Reeve. 4, 5.
Glycimeris americana Defr. 3.
Leda acuta Conr. 3, 4, 5.
Cardita floridana Conr. 1, 5.
Cuna dalli Van. 3, 4, 5.
Crassinella lunulata Conr. 3, 4, 5.
Anisodonta elliptica Recl. 5.
Erycina floridana Van. 5.
Lucina chrysostoma Phil. 4, 5.
Phacoides trisulcatus Conr. 5.
Phacoides nassula Conr. 4, 5.
Phacoides floridanus Conr. 4, 5. 7.
Phacoides radians Conr. 4, 5. 7.
Phacoides crenella Dall. 3, 4, 5. 7.

oides amiantus Dall. 4, 5, 7.
ricella quadrisulcata Orb. 5.
odonta punctata Say. 5, 7.
ia arcinella L. 4.
ium robustum Sol. 3, 4, 5, 7.
ium isocardium L. 1, 4, 5.
ium muricatum L. 3, 4.
ium serratum L. 3, 4, 5, 7.
ium mortoni Conr. 6.
us mercenaria L. 1, 4.
us mercenaria mortoni Conr. 5, 7.
us cribraria Conr. 4, 5, 7.
us cancellata L. 4, 5, 7.
us pygmæa Lam. 4, 5, 7.
us cuneimeris Conr. 4, 5.
na gemma purpurea Lea. 4.
starte triquetra Conr. 4, 5.
trix simpsoni Dall. 4, 5.
trix eucymata Dall. 7.
trix conradiana Dall. 4, 5.
trix texasiana Dall. 3.
sta nimbosa Sol. 1, 4, 5, 6, 7.
nia discus Rvc. 1, 4, 5, 7.
cola pholadiformis Lam. 3, 5.
Donax variabilis Say. 1, 3, 4, 5, 6, 7.
Donax obesa Orb. 3, 4, 5, 7.
Tagelus divisus Spengl. 3, 5.
Tellina magna Spengl. 5.
Tellina alternata Say. 1, 3, 7.
Tellina tenera Say. 3.
Tellina polita Say. 4.
Tellina consobrina Orb. 5, 7.
Tellina lintea Conr. 5, 7.
Tellina pauperata Orb. 4, 5.
Macoma constricta Broug. 3.
Macoma brevifrons Say. 7.
Macoma tenta Say. 5.
Tellidora cristata Recl. 5.
Strigilla flexuosa Say. 4, 5, 7.
Metis intastriata Say. 4.
Abra æqualis Say. 3, 4, 5, 7.
Ervilia concentrica Gld. 4, 5.
Semele bellastriata Conr. 4, 7.
Spisula solidissima similis Say. 1, 3, 4, 5, 7.
Mulinia lateralis Say. 3, 4, 5, 7.
Labiosa canaliculata Say. 1, 3, 7.
Panopea bitruncata Conr. 5.
Ensis directus Conr. 5.
Barnea costata Say. 3.

Class SCAPHOPODA.

alium disparile Orb. 4, 5.

Class GASTROPODA.

atina candei Orb. 4, 5.
hnella bidentata Orb. 3.
us occidentalis A. Ad. 5.
mpus coffea gundlachi Pfr. 6.
bra dislocata Say. 4, 5.
gilia cerina K. and S. 4, 5.
ellaria reticulata L. 5.
a literata Lam. 1, 3, 4, 5.
lla mutica Say. 4.
Olivella pusilla Marr. 4, 5.
Marginella apicina Menke. 5.
Fasciolaria tulipa Lam. 4, 5.
Fulgur pyrum Dillw. 4, 5.
Fulgur perversa L. 4, 5.
Melongena corona Gmel. 4.
Tritonidea cancellaria Conr. 7.
Nassa acuta Say. 4, 5.
Columbella avara Say. 5.

Columbella obesa Say. 4, 5.
Murex fulvescens Sowb. 3.
Purpura hæmastoma L. 7.
Pyramidella crenulata Holmes. 4, 5.
Turbonilla conradi Bush. 3, 4, 5.
Cassis inflata Shaw. 4, 5, 6.
Pyrula papyratia Say. 3, 4, 5.
Strombus pugilis L. 4, 5.
Strombus pugilis alatus Gmel. 4, 6.
Seila adamsii H. C. Lea. 5.
Cæcum pulchellum Stimp. 5.
Cæcum cooperi Smith. 5.
Meioceras nitida Stimp. 5.
Litorina irrorata Say. 4, 6.
Rissoina browniana Orb. 5.
Crepidula fornicata L. 3, 4, 5, 6.
Crepidula plana Say. 4, 5.
Crepidula aculeata Gmel. 3.
Natica pusilla Say. 4, 5.
Polinices duplicatus Say. 1, 3, 4, 5, 7.
Sigaretus perspectivus Say. 1, 3, 4, 5.
Turbo castaneus crenulatus Gmel. 5, 6.
Teinostoma cryptospira Verr. 5.
Vitrinella mooreana Van. 5.

The following species are believed to be new:

Vitrinella mooreana n. sp. Fig. 1.

Shell umbilicate, discoidal, with about 4½ whorls. The first whorl is yellow and smooth, the remaining are white and sculptured with heavy spiral cords, of which there are 5 on the penultimate whorl and 7 on the body whorl above the periphery. The granulate interstices are about as wide as the spiral cords. The base is sculptured with very faint spiral striæ. The aperture is oblique and suborbicular, with the columella broadly thickened.

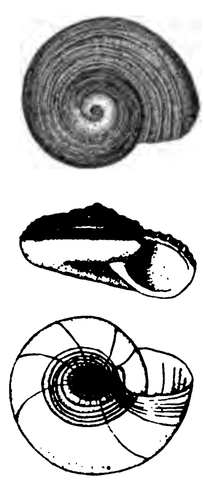


Fig. 1.

Alt. 1.2, diam. 2.75; aperture alt. 1, diam. 1 mm.

This species was collected by Mr. Clarence B. Moore on the gulf side of Crooked Island, off St. Andrew's Sound, Calhoun county, Florida. The types are No. 84,611, A. N. S. P. It is named in honor of its collector, Mr. Moore. The species seems to be near *V. multistriata* Verr., but differs in having 7 strong spiral cords above the periphery and a nearly smooth base. It differs from *V. striata* Orb. in having a thickened columella.

Eryoina floridana n. sp. Fig. 2.

Shell small, white, thin, subquadrate, with the ends nearly evenly rounded, almost equilateral, beaks low, surface sculptured with irregular lines of growth. Hinge with a central pit and rather large lateral

teeth, four being in one valve and two in the other. The adductor scars are rather large, connected by an irregular pallial line.

Alt. 5, length 8.25, thickness of 1 valve 1.75 mm.

This species was collected by Mr. Clarence B. Moore on the gulf side of Crooked Island, Florida. The types are No. 83,876, A. N. S. P. Prof. W. H. Dall kindly compared it with his species from the Florida Pliocene. It is very near *E. kurtzii* Dall, but seems to be more delicate, with stronger laterals and more evenly rounded ends.

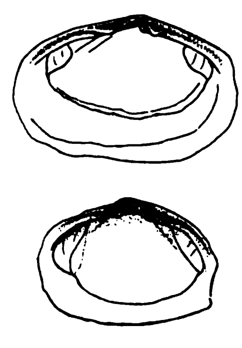


Fig. 2.

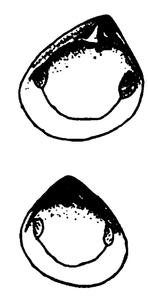


Fig. 3.

Cuna dalli n. sp. Fig. 3.

Shell subtriangular, inequilateral, purple in the center becoming lighter near the edge. surface sculptured with concentric costæ, ventral margin smooth, adductor muscle scars rather large, hinge strong and broad. The right valve has three cardinals, the anterior is long and low, the central large and triangular, the posterior short and narrow, situated at the edge of the large ligament pit. In the left valve the anterior cardinal is long and low, the curved central is smaller than the central of the opposite valve, the posterior cardinal is a small ridge at the edge of the ligament. Pallial line entire.

Alt. 2.5, length 2.4, thickness of one valve .8 mm.

The types of this species are No. 84,612, A. N. S. P. They were collected by Mr. Moore at Indian Pass, Apalachicola Bay, Florida; he also collected the same species at St. Joseph Bay and on the gulf side of Crooked Island, off St. Andrew's Sound, Florida.

This species is more rounded and inequilateral than *Parastarte triquetra* Conr., and lacks the crenulation on the ventral margin. It has a broader hinge than *Gemma gemma* Totten, but the surface sculpture is very similar. It is more inequilateral than *Cuna concentrica* Hedley, but the hinge is similar. *Cuna particula* Hedley is more rounded and truncate, with a slightly different hinge.

DECEMBER 1.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Twenty-four persons present.

The deaths of the following members were announced: Enoch Lewis, November 15, 1902; Charles W. Trotter, August 5, 1903; Mrs. J. Edgar Thomson, November 24, 1903, and Charles Schaeffer, M.D., November 23, 1903.

ON the announcement of the death of DR. CHARLES SCHAEFFER, the following minute was unanimously adopted:

Conscious of the loss it has sustained in the death of DR. CHARLES SCHAEFFER, the Academy desires to place on record a minute to that effect. Since his election to membership in 1861, Dr. Schaeffer had been loyally interested in the well-being and growth of the society. He served acceptably as a member of the Council and of the Library Committee. His efficiency as Secretary of the Botanical, the Mineralogical, and the Biological and Microscopical Sections is proof of the wide sphere of his nature-studies, while his skill in photography enabled him to permanently place the results of his work in the cabinet and in the field at the service of his fellow-students. He thus alike recorded with loving care and exquisite fidelity the floral beauties of the fields and dells he had known from childhood and the glories of the distant snow-clad peaks of the western mountains, where for many years he periodically drew store of health and inspiration.

He made the needs of the Academy at large matters of personal concern, and was ever ready with wise counsel and practical encouragement, while in his intercourse with his fellow-members he was notably gentle, courteous and sympathetic. His memory will be held in affectionate regard.

DR. BENJAMIN SHARP made a communication on the fishes of Nantucket. It will be incorporated in a paper to be published in the next volume of the PROCEEDINGS.

Ganglia of Odonata.—DR. PHILIP P. CALVERT spoke of the abdominal and thoracic ganglia of dragonflies (Odonata), stating that the eight pairs constituting the abdominal portion of the ventral nerve cord of young larvæ are reduced to seven, in later larval life, by the fusion of the first pair with the third thoracic (*Æschna*, *Anax*). The second abdominal pair move forward to lie in the first abdominal segment, leaving the second segment (alone of the first eight) without ganglia. This later condition is likewise that of the adults of the suborder Anisoptera, as far as known. Adults of at least some species of the suborder Zygoptera show some differences (Calvert, *Proc. Calif. Acad. Sci.*, 3d series, I, p. 410, 1899).

The following were accepted for publication:

MEXICAN LAND AND FRESHWATER MOLLUSKS.

BY HENRY A. PILSBRY.

The following report is based chiefly upon material collected by Mr. S. N. Rhoads during two expeditions to Mexico; the first in February, March and April, 1899, the second undertaken early in 1893, and unfortunately cut short by his recall to Philadelphia after only a few days in the field. Occasion has been taken to include sundry notes upon and descriptions of new Mexican and Central American mollusks in the collection of the Academy, worked up in the course of study upon Mr. Rhoads' collection; the whole being supplemental to the great works upon this fauna of Fischer and Crosse, E. von Martens and H. Strebel.[1]

The species of greatest interest in Mr. Rhoads' collection is that I have elsewhere described as *Metostracon mima*, an extraordinary slug-like snail, which contributes not only a genus new to Mexico, but a totally new line of differentiation in the family *Helicidæ*.

From the faunistic standpoint, the collections made at Victoria in Tamaulipas, and at Monterey and the adjacent mining village of Diente in Nuevo Leon, are of great importance, confirming the northward extension of the Neotropical region in east Mexico, already mapped on the evidence of the birds of that district. The localities mentioned are sufficiently alike in their faunæ to be considered together. In a total of 46 species,

Fifteen are identical with characteristic species of Vera Cruz Province;

Three are identical with species of the States of Mexico, Jalisco, etc.;

Ten are identical with species of Texas

(Five of the above occur from Vera Cruz to Texas);

Twenty are species special to Nuevo Leon and Tamaulipas, but belonging to Vera Cruzian genera or smaller groups;

Three are species special to Nuevo Leon and Tamaulipas, but belonging to groups ranging from Vera Cruz to Texas.

[1] As the literature has been fully cited by these authors, I have thought the insertion of references to be needless, except in dealing with new species described in my previous paper on Mr. Rhoads' collection, and in a few other cases inadequately treated in the larger works, or omitted therefrom.

There are therefore 33 distinctively Neotropical species; 5 species as characteristic of the Texan fauna; and 8 species with a wide distribution in both regions, or belonging to groups with such a distribution. Part of the latter are doubtless of Neotropical origin ultimately, but in two cases (*Zonitoides arboreus* and *Bifidaria curvidens*) truly Palæarctic.

HELICIDÆ.

Helix aspersa Müll.

Tlalpam, State of Mexico, and Pueblo, State of Pueblo; at both places in abundance. At Tlalpam they are all small, diam. 24 to 29 mm., and similar to Kobelt's fig. 364 of Plate 69 in Vol. III (n. F.) of Rossmässler's *Iconographie*, except that there are 5 or 4 bands, as in fig. 350 of Pl. 67. The shells from Pueblo are larger, 26 to 33 mm. diam., with band formulæ varying from 1 (2 3) 4 5 to (1 2 3) (4 5).

Lysinoe humboldtiana buffoniana (Pfr.).

Diente, near Monterey, Nuevo Leon. Adult shells measure from 27 x 33 to 37 x 42 mm.

Trichodiscina cordovana (Pfr.).

Texolo, V. C.; cañon 4 miles west of Victoria, Tamaulipas; Diente, near Monterey, Nuevo Leon. The last two localities extend the range of this species far to the north.

Metostracon mima Pilsbry.

Proc. Malac. Soc. London, IV, p. 27, Pl. 3, figs. 1-11.

Morelia and Uruapam, Michoacan.

Xanthonyx salleanus (Pfr.).

Texolo, V. C.

Praticolella berlandieriana (Moric.).

Around Victoria, Tamaulipas, and at Monterey and Topo Chico, Nuevo Leon.

Praticolella griseola (Pfr.).

Antigua, V. C.

Praticolella ampla (Pfr.).

Texolo, V. C.

Praticolella strebeliana Pils. Pl. LI, figs. 6, 6*a*.

Proc. Acad. Nat. Sci. Phila., 1899, p. 394.

Diente, near Monterey, Nuevo Leon.

Polygyra plagioglossa (Pfr.).

Patzcuaro, Michoacan; Pueblo, State of Pueblo.

Polygyra suprazonata Pils. Pl. LXI, figs. 1, 1*a*, 1*b*.

Proc. Acad. Nat. Sci. Phila., 1899, p. 393.

Tzintzuntzan, State of Michoacan.

Polygyra rhoadsi Pils. Pl. LXI, figs. 2, 2*a*, 2*b*.

Proc. Acad. Nat. Sci. Phila., 1899, p. 392.

Topo Chico, near Monterey, Nuevo Leon.

Thysanophora conspurcatella (Morel.).

Antigua, V. C.

Thysanophora impura (Pfr.).

Antigua, V. C.

Thysanophora proxima Pils. Pl. XLIX, figs. 2, 2*a*.

Proc. Acad. Nat. Sci. Phila., 1899, p. 394.

Uruapam, Huingo, Patzcuaro and Morelia, in the State of Michoacan; the types from the former locality.

Thysanophora horni (Gabb).

Victoria, State of Tamaulipas, in chaparral; Topo Chico, near Monterey, Nuevo Leon. The specimens have been carefully compared with the types from Arizona, and are undoubtedly this species, which, when fresh, has a sparsely hairy cuticle. See *Nautilus*, XIII, 98. It is new to the Mexican fauna.

Thysanophora coloba Pilsbry.

Proc. Acad. Nat. Sci. Phila., 1893, p. 403, figs. in text.

Polvon, department of Chinandega, western Nicaragua (McNiel expedition). A minute species, diam. 1.8 mm., overlooked by the authors of the *Biologia* and *Mission Scientifique*, and inserted here to rescue it from oblivion.

In this connection it may be mentioned that *Pupisoma americanum* Mlldff., *Nachrbl. d. d. malak. Ges.*, 1899, p. 91, is apparently a synonym of *Thysanophora cæca*.

Thysanophora fischeri n. sp. Pl. XLIX, figs. 6, 6*a*.

Shell umbilicate, depressed-conic, thin, pale brown. Surface dull, sculptured with thin cuticular laminæ more oblique than the lines of growth. Spire conic, the apex obtuse. Whorls 4, very convex, the last rounded peripherally and beneath. Umbilicus contained about 7 times in the diameter of the shell. Aperture quite oblique, rounded-lunate, the peristome thin and simple, columellar margin dilated. Alt. 1.5, diam. 2.4 mm.

Tamaulipas, in a cañon about 4 miles west of Victoria. Types No. 85,911, A. N. S. P., collected by S. N. Rhoads, 1903.

This species is almost exactly intermediate between *T. granum*

Strebel and *T. conspurcatella* (Morel.). It is lower than the former species, with a larger umbilicus, and higher than the latter, with the umbilicus narrower. It unites the group of species referred to *Acanthinula* by von Martens with the typical forms of *Thysanophora*. Named in honor of one of the authors of the volumes on mollusks in the *Mission Scientifique au Mexique*.

Thysanophora tatei Pilsbry. Pl. XLIX, figs. 3, 3*a*, 3*b*.

Helix blakeana Tate, Amer. Jour. of Conch., V, p. 155, Pl. 16, fig. 3 (1870). Not *H. blakeana* Newc., 1861.
Thysanophora tatei Pils.

Shell depressed, discoidal, the spire but slightly convex; openly umbilicate, the width of the umbilicus contained about 3¾ times in the diameter of the shell; thin, slightly translucent, grayish corneous. Sculpture of fine, rather close but somewhat irregularly spaced thread-like rib-striæ in harmony with growth-lines. Whorls 3½, convex, slowly increasing to the last, which is double the width of the preceding, rounded peripherally and beneath. Suture very deep and conspicuous. Aperture slightly oblique, round-lunate, about one-fourth of the circle excised by the preceding whorl; lip thin and simple throughout, the margins converging. Alt. 1.8, diam. 3 mm.

Chontales forest, Nicaragua.

The unique type is No. 58,065, A. N. S. P., collected by Ralph Tate.

The name given by Tate to this species is preoccupied. It was omitted from Crosse and Fischer's great work, and placed in the synonymy of *Pseudohyalina minuscula* by von Martens. It is related to some undetermined species in the collection of the Academy from northern South America, but has no very close relatives among Mexican snails, so far as I know. The generic position of this snail is uncertain, but it has more the appearance of *Thysanophora* than of any Zonitid group. The thread-like rib-striæ are not cuticular, but more like the striæ of *Pyramidula*.

BULIMULIDÆ.

Bulimulus dealbatus Say.

Monterey, State of Nuevo Leon. A slender form, closely mottled and streaked.

Bulimulus dealbatus schiedeanus Pfr.

Saltillo, Coahuila (S. N. Rhoads, 1899). The large typical form of *schiedeanus*.

Bulimulus alternatus mariæ Alb.

Monterey, State of Nuevo Leon; in chaparral near Victoria, Tamaulipas. Specimens from Monterey are like that from Laredo, Texas,

figured in *Manual of Conchology*, XI, Pl. 17, fig. 24. Those from near Victoria are similarly marked, but are smaller. Both have the lip thickened and the mouth brown or purplish-brown inside, the tint rather dilute in some specimens.

Drymæus emeus (Say).

Cañon 4 miles west of Victoria, Tamaulipas. Specimens like von Martens' figures 7, 7*a*, of Plate 14 of the *Biologia*. This is far north of all previous records.

Drymæus sulphureus (Pfr.).

Texolo, V. C.

Drymæus hegewischi (Pfr.).

Texolo, V. C.

Drymæus dunkeri (Pfr.).

Patzcuaro and Tzintzuntzan, Michoacan.

UROCOPTIDÆ.

Microceramus mexicanus (Marts.).

Man. of Conch. (2), XVI, p. 156, Pl. 26, figs. 26, 27 (specimen from Diente).

Around Victoria, Tamaulipas, and Diente, near Monterey, Nuevo Leon. This form is readily distinguishable from both *M. concisus* on the south and *M. texanus* on the north. It occurred in numbers, and is no doubt a widely spread and characteristic east Mexican species.

Subgenus GYROCION nov.

Slender cylindrelloid snails with the axis large, hollow and smooth, apex smooth and apparently retained entire. Whorls extremely numerous and narrow, some intermediate ones with a spiral lamella within on the basal partition. Characters of the aperture unknown.

This group is proposed for an imperfectly known snail which cannot well be placed in any of the recognized genera, though it apparently is related to *Epirobia* and *Holospira*. The former group differs by its rugose axis and in the absence of a spiral basal lamella. Further examples of the complete shell and a knowledge of the dentition are necessary for an adequate definition of the position of the group.

Epirobia (Gyrocion) mirabilis n. sp. Pl. L, figs. 10, 10*a*.

The shell is cylindric below, gradually tapering above to an entire apex; composed of very many narrow and strongly convex whorls; light brown; finely and closely costulate-striate vertically. The apex is obtuse, smooth and rather globular; the following three whorls are equal in diameter; the calibre of the shell then slowly enlarges until

the cylindric portion has a diameter of 2.5 mm. The hollow central axis is nearly one-third the diameter of the shell, and is smooth. In the lower part of the tapering portion, a low lamella revolves in the middle of the floor or basal wall of the whorls. Length of the fragment of the tapering portion figured 6 mm.; whorls 17. Length of cylindric fragment 4.2 mm.; whorls about 5½.

Diente, near Monterey, Nuevo Leon. Types No. 85,914, A. N. S. P., two fragments collected by S. N. Rhoads, 1903.

PUPIDÆ.

Pupoides marginatus (Say).

Topo Chico, near Monterey, Nuevo Leon. Abundant.

Bifidaria contracta (Say).

Texolo, V. C. (Rhoads.) Hitherto known from only two places in Mexico, Orizaba, V. C., and Yautepec, Moreles, collected by the Heilprin expedition of 1890.

Bifidaria prototypus Pils. Pl. L, figs. 7, 7*a*.

Proc. Acad. Nat. Sci. Phila., 1899, p. 400.

The angular and parietal lamellæ are more separated than in any other species of the typical group of *Bifidaria*.

Bifidaria pellucida hordeacella (Pils.).

Proc. Acad. Nat. Sci. Phila., 1900, p. 594.

Antigua, V. C.; cañon 4 miles from Victoria, Tamaulipas.

Bifidaria curvidens (Gld.).

Cañon 4 miles west of Victoria, State of Tamaulipas.

This species is new to the Mexican fauna.

Strobilops strebeli (Pfr.).

Diente, near Monterey, Nuevo Leon.

ZONITIDÆ.

Omphalina martensiana n. sp. Pl. XLVIII, figs. 7, 7*a*, 7*b*.

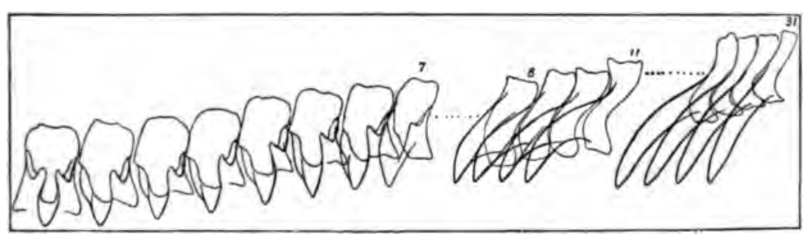
Shell depressed, shaped about like *O. lucubrata* Say; umbilicate; pale green with a broad maroon band at the periphery, another below the suture, leaving a pale-green band above the periphery, visible on the whorls of the spire just above the suture, the first two whorls greenish; the base, inside the peripheral maroon band, is also green. Surface glossy, sculptured above with almost regularly spaced radial grooves in harmony with the lines of growth, the base marked with growth-wrinkles; between the radial grooves there are fine, sparse, forwardly-descending, very minute raised lines, which on the base are more

numerous and in a spiral direction. Whorls 5, slightly convex, regularly widening to the last, which is fully double the width of the preceding, rounded peripherally. Aperture oblique, rounded-lunate. Alt. 13.5, diam. 22.3 mm.; width of umbilicus 2 mm.

Guatemala: Huehuetenango. Type No. 85,521, A. N. S. P., collected by Mr. Gustav Eisen, and communicated to me by Mr. Fred L. Button.

This is a superb *Omphalina*, perhaps the finest of the genus in color and sculpture. In proportions it is near *O. lucubrata* Say, from which it differs in coloration and sculpture, the radial grooves of the upper surface being like those of *Vitrea indentata* on a large scale.

With the red bands of *O. bilineata*, it is a much larger shell, quite different in sculpture.



Teeth of *Omphalina martensiana.*

The jaw is like other species of the genus. The radula has 62.7.1.7.62 teeth, the seventh on each side being transitional. The teeth at the middle of the marginal series (fig. 31) have unusually long and graceful cusps. *Omphalina bilineata* has fewer lateral teeth, only 5, the last being a transition tooth.

The name is to honor the author of the splendid volume on mollusks in the *Biologia Centrali Americana.*

Omphalina bilineata (Pfr.).

Near Jalapa, V. C. Of 5 specimens, four have narrow bands at periphery and suture, the other one being bandless.

Omphalina lucubrata (Say).

Texolo, V. C., A fine series, taken by Mr. Rhoads in 1899.

Omphalina montereyensis Pils. Pl. XLVIII, figs. 6, 6*a*, 6*b*.

Proc. Acad. Nat. Sci. Phila., 1899, p. 395.

Diente, a village near Monterey, Nuevo Leon (S. N. Rhoads, 1899 and 1903). A large series shows this to be very constant in shape and in the comparative size of the umbilicus, the width of which is contained

about 9 or 10 times in that of the shell. Most of the specimens are smaller than the type lot.

Alt. 6, diam. 12.5, width of umbilicus 1 mm.

Alt. 6, diam. 10.5, width of umbilicus 1 mm.

Alt. 6, diam. 11.3, width of umbilicus 1 mm.

Omphalina montereyensis victoriana n. subsp. Pl. XLVIII, figs. 5, 5*a*, 5*b*.

Similar to the typical form except that the umbilicus is constantly larger, its width contained about 6 times in that of the shell. Alt. 5.5, diam. 10.5, width of umbilicus 1.7 mm.

Cañon 4 miles west of Victoria, Tamaulipas. Types No. 85,912, A. N. S. P.

Over a hundred specimens show the slight difference between this and *O. montereyensis* to be constant.

Omphalina carinata (Strebel).

Jalapa, in forest (Rhoads).

Vitrea indentata (Say).

Uruapam, Michoacan. Some of the specimens are perforate, others apparently closed. They are rather small, like the common typical form, not like the large, perforate, Texan variety.

Zonitoides arboreus (Say).

Diente, near Monterey, Nuevo Leon; Texolo, V. C. The specimens from the former place wholly typical; that from the latter not quite full-grown and whiter than usual, so that I am not quite positive about the identification.

Zonitoides minusculus (Binn.).

Topo Chico, near Monterey, State of Nuevo Leon.

Pycnogyra berendti (Pfr.).

Texolo, V. C.

Guppya trochulina (Morel.).

Texolo, V. C.; Patzcuaro and Morelia, Michoacan.

Guppya elegans (Strebel).

Diente, near Monterey, Nuevo Leon; Uruapam, Michoacan. An allied species I have not identified was taken in abundance in a cañon near Victoria, Tamaulipas.

Guppya gundlachi (Pfr.).

Tamaulipas, in chaparral, near Victoria, and in a cañon about four miles west of that place (Rhoads, 1903). Also in the collection of the Academy from Polvon, Nicaragua, collected by Ralph Tate.

Guppya micra n. sp. Pl. XLIX, figs. 5, 5*a*, 5*b*.

Shell distinctly perforate, low-trochoidal, the spire low conic, obtuse at the summit, periphery rounded, the base convex; yellowish, slightly transparent, nearly smooth. Whorls 4½, quite convex, slowly and regularly increasing, parted by a well-impressed suture. Aperture lunate, only slightly oblique, the columellar margin dilated. Alt. 1.5, diam. 2 mm.

Patzcuaro, Michoacan. Types No. 85,913, A. N. S. P., collected by S. N. Rhoads, 1899. Also cañon 4 miles west of Victoria, Tamaulipas.

ENDODONTIDÆ.

Pyramidula victoriana n. sp. Pl. XLIX, figs. 1, 1*a*, 1*b*.

Shell depressed, discoidal, the spire flat, base convex, openly umbilicate, the width of umbilicus contained about 3½ times in that of the shell; thin, greenish corneous. Surface closely and regularly sculptured with oblique, thread-like riblets, following the direction of growth-lines. Whorls 3½, the last double the width of the preceding, rounded at the periphery. Aperture oblique, subcircular, about one-fifth or one-sixth of the circle excised by the preceding whorl; peristome thin and simple, the ends converging.

Alt. 1.4, diam. 3.4 mm.

Alt. 1.5, diam. 4 mm.; whorls 3¾.

Cañon 4 miles west of Victoria, State of Tamaulipas. Types No. 85,907, A. N. S. P. Also in chaparral near Victoria.

Quite unlike any North American species in the wide last whorl and flat spire, as well as the nearly round mouth. It has the sculpture of *Pyramidula*, and is probably a member of that genus. The only fresh specimen is figured, and probably is not quite mature. Another bleached and imperfect one is larger, with a fourth of a whorl more. Four specimens were taken.

Sphyradium polvonense (Pils.).

Pupa polvonensis Pilsbry, Proc. Acad. Nat. Sci. Phila., 1894, p. 31, Pl. I, fig. 11.

Shell openly perforate, subcylindric, a little tapering upward, the summit rounded. Whitish above, with some narrow dark streaks, the last whorl or two olivaceous-brown, with narrow darker and light oblique streaks. Surface shining, faintly marked with fine growth lines only. Whorls 5½ or 6, slightly convex, the last very convex beneath. Aperture quite oblique, truncate-ovate. Outer lip thin and simple; columellar lip broadly dilated above. Length 2.5, diam. 1.3 mm.

Western Nicaragua: Polvon, in the department of Chinandega. Types are No. 5,096, A. N. S. P., collected by the McNeil expedition.

Compared with the Holarctic *Sphyradium edentulum*, this tropical species is less cylindric, tapers more, and the whorls are much less convex; moreover, the color is different.

It was figured in these *Proceedings* under the name *Pupa polvonensis* many years ago. A description is now supplied. It is the first Neotropical species of the genus, but until jaw and teeth are examined the generic position will remain uncertain, although the shell has the form of *Sphyradium*.

Pyramidula hermanni (Pfr.).

Morelia, Uruapam and Patzcuaro, Michoacan (Rhoads, 1899).

PHILOMYCIDÆ.

Philomycus crosseanus Strebel.

Texolo, V. C. A single specimen.

GLANDINIDÆ.

The detail figures of sculpture in all cases are taken from the front of the last whorl immediately below the suture. Except where otherwise indicated on the plates, the other figures of *Glandina* are natural size.

Glandina vanuxemensis Lea.

Pueblo, State of Mexico.

Glandina michoacanensis Pils. Pl. XLVII, figs. 1, *1a*, *1b*.

Proc. Acad. Nat. Sci. Phila., 1899, p. 397.

Uruapam, Michoacan. Types No. 77,181, A. N. S. P. The figures show adult and young shells.

Glandina huingensis n. sp. Pl. XLVII, figs. 2, *2a*, *2b*.

Shell obese, oblong, rather solid, fleshy-brown in color. Surface glossy; sculptured with irregular growth-wrinkles, which are strengthened into folds at the suture, which is sharply, irregularly denticulate. Spire short, very obtuse at the summit. Whorls 5½, the first 2½, smooth, next whorl narrower, the following ones rapidly widening, the last half-turn of the suture more obliquely descending. Aperture two-thirds the length of the shell. Columella deeply concave. Length 31, diam. 17, length of aperture 21.7 mm.

Huingo, Michoacan. Types No. 77,179, A. N. S. P., collected by S. N. Rhoads, 1899.

This species resembles *G. indusiata* Pfr. in shape, and it may prove to be a variety of that species; but there is no trace of the epidermis

described and figured by Fischer and Crosse, nor of the spiral striation. It seems, therefore, advisable to describe the Huingo form.

Glandina victoriana n. sp. Pl. XLVII, figs. 4, 4a, 4b.

Shell cylindric-oblong, slender, rather thin; very glossy, fleshy-brown marked at wide intervals with opaque-white longitudinal lines. Sculptured throughout with close, regular, smooth and rounded rib-striæ, as wide as their intervals, and somewhat denticulating the suture. Spire convex-conic, the apex obtuse. Whorls 7, the first 3 smooth. Aperture about half the length of the shell, narrowly acuminate. Outer lip arched forward a little in the middle. Columella concave, oblique below, and truncate as usual.

Length 37, diam. 11.7, length of aperture 19 mm.

Length 44, diam. 14, length of aperture 21 mm.

Cañon 4 miles west of Victoria, State of Tamaulipas. Types No. 85,918, A. N. S. P., collected by S. N. Rhoads, 1903.

This species is distinguished by its narrow elongate shape, smooth, regular and close riblets without spiral lines, and the occasional white lines marking temporary growth-arrests. It is related to *G. texasiana*, but differs in the markedly elongate shape, etc.

Glandina rhoadsi Pilsbry. Pl. XLVII, figs. 3, 3a, 3b.

Proc. Acad. Nat. Sci. Phila., 1899, p. 395.

Diente, near Monterey, Nuevo Leon. Types No. 77,172, A. N. S. P. An additional lot, collected by Mr. Rhoads in 1903, shows some variation in the shape of the columella, which may be either nearly straight below or decidedly curved. The darker streaks mentioned in the original description are never conspicuous, and often are seen only on close examination. The striation is not clearly enough indicated in fig. 3.

Length 54, diam. 19, length of aperture 29 mm.

Length 50, diam. 17, length of aperture 25 mm.

Length 53, diam. 18.5, length of aperture 26 mm.

Length 47, diam. 17, length of aperture 25 mm.

Glandina delicata n. sp. Pl. XLVIII, figs. 1, 1a, 1b.

Shell pale yellowish-corneous, thin and delicate; fusiform, tapering toward both ends. Surface closely rib-striate, the costulæ about as wide as the intervals, and slightly weaker at the base. Spire tapering to a rather small apex, the first 3 to 3½ whorls smooth. Aperture more than half the shell's length, the outer lip thin, but slightly arched forward, receding at base. Columella short and nearly straight, abruptly truncate.

Length 23, diam. 9, length of aperture 14 mm.

Tamaulipas: Cañon 4 miles west of Victoria. Types No. 85,917, A. N. S. P., collected by S. N. Rhoads, January 21, 1903.

A small, sharply striate species. The aperture is larger than in *G. delicatula*. Another specimen of the type lot has a somewhat shorter spire, measuring: length 22.5, diam. 9, length of aperture 13.3 mm.

Glandina delicata altiocla n. subsp. Pl. XLVIII, fig. 2.

Shell smaller and more cylindric than *G. delicata*, with comparatively stronger sculpture, 6 whorls and decidedly curved columella. Length 17, diam. 6.5, length of aperture 10 mm.

Diente, near Monterey, State of Nuevo Leon. Types No. 77,174, A. N. S. P., collected by S. N. Rhoads.

Glandina oblonga tamaulipensis n. subsp. Pl. XLVII, figs. 6, 6a, 6b.

Shell narrowly oblong, the last whorl somewhat cylindric, spire slowly tapering to a rather large, obtuse apex. Surface very glossy, smooth except for irregularly spaced, rather distinct and unequal, impressed lines in the direction of lines of growth; and the suture is bordered with fine short and close folds. Whorls fully 7½, regularly increasing, the last suture not more obliquely descending. Aperture about half the length of the shell, the outer lip arched forward in the middle, basal lip retracted; columella short, very concave above and convex below.

Length 15, diam. 5.7, length of aperture 7.5 mm.

Length 15, diam. 5.3, length of aperture 7.3 mm.

Tamaulipas, in a cañon about 4 miles west of Victoria, elevation about 3,000 feet. Types No. 85,910, A. N. S. P., collected by S. N. Rhoads, January 21, 1903. A single specimen taken at Diente also seems to belong here.

This form, which was found in abundance, is evidently close to *G. oblonga* Pfr.,[2] but it is less plicate below the suture and the columella is more curved. Fig. 6 represents a young shell.

Glandina dalli Pilsbry. Pl. XLVII, figs. 5, 5a.

Proc. Acad. Nat. Sci. Phila., 1899, p. 396.

Diente, near Monterey, Nuevo Leon. Types No. 77,173, A. N. S. P.

Glandina monilifera Pfr.

Glandina iheringi Pils., Nautilus, XIV, p. 4 (May, 1900), is a synonym of this species.

Salasiella joaquinae Strebel.

Several specimens taken at Diente, near Monterey, N. L., seem referable to this species, described from the Province of Vera Cruz.

[2] *Biologia Centrali-Amer.*, Moll., p. 69, Pl. 5, fig. 6.

Salasiella perpusilla (Pfr.). Figs. 2, 3.

Diente, Nuevo Leon. Figured for comparison with the following species. The specimens from Orizaba formerly identified by me as *S. perpusilla*,[3] appear on renewed study with more material to be *S. modesta* Pfr. As Strebel has pointed out, *S. perpusilla* is more convex below the suture than *S. modesta;* and the same feature distinguishes it from *S. minima* and *S. subcylindrica*. The specimen from Diente shown in fig. 3 measures: length 3.3, diam. 1.4, length of aperture 1.9 mm.

Salasiella modesta (Pfr.) Figs. 4, 5.

Glandina (*Salasiella*) *perpusilla* Pilsbry, Proc. Acad. Nat. Sci. Phila., 1891, p. 311.

Two specimens from Orizaba, an adult and a young one, are figured,

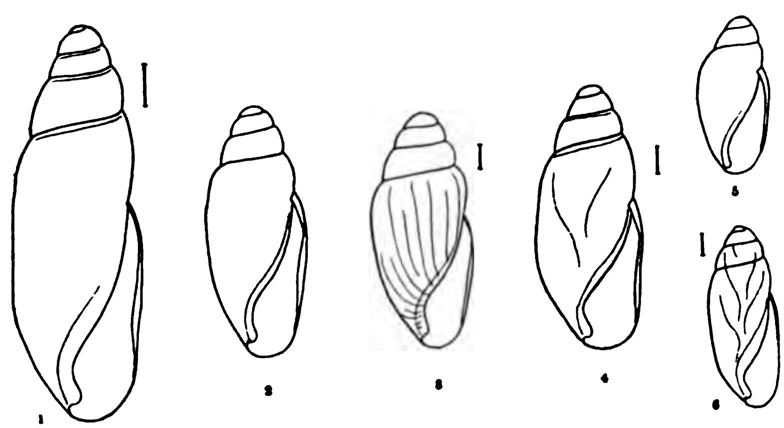


Fig. 1. *Salasiella subcylindrica*. Diente, near Monterey.
Figs. 2, 3. *Salasiella perpusilla*. Diente, near Monterey.
Figs. 4, 5. *Salasiella modesta*. Orizaba.
Fig. 6. *Salasiella minima*. Orizaba.
(All figures drawn with camera lucida to the same scale.)

the latter for comparison with *S. minima*, the former with *S. subcylindrica*. The specimen drawn in fig. 4 measures: length 3.7, diam. 1.47, length of aperture 2.1 mm.

Salasiella minima n. sp. Fig. 6.

Very minute, cylindric-oblong, almost equally obtuse at both ends; thin, corneous and transparent, showing the internal partitions through the shell. Surface glossy and but very faintly marked with growth-lines. Whorls 4; suture with a narrow margin by transparence. Other characters as usual in the genus. Length 2.6, diam. 1, length of aperture 1.6 mm.

[3] *Proc. Acad. Nat. Sci. Phila.*, 1891, p. 311.

Hills around Orizaba, about 500 feet above the town. Type No. 58,070, A. N. S. P., collected by Witmer Stone, of the Heilprin expedition of 1890.

This smallest species of the genus is not unlike *S. modesta* in shape, but it is built on a much smaller scale. For comparison I figure a young specimen of *S. modesta*, the different contour of which may be readily appreciated.

Salasiella subcylindrica n. sp. Fig. 1.

Shell distinctly cylindric, the rather long spire tapering to an obtuse apex; corneous-white; smooth except for a few impressed lines following the direction of growth-lines. Whorls 4¾, slightly convex, the last flattened peripherally. Suture margined by transparence. Aperture of the usual shape; outer lip strongly arched forward in the middle, retracted above and below. Columella as in other species of the genus. Length 5.6, diam. 1.8, length of aperture 3.15 mm.

Diente, near Monterey, State of Nuevo Leon. Types No. 77,169, A. N. S. P., collected by S. N. Rhoads, 1899.

This species is larger and more cylindric than *S. modesta*, and the columella is less concave. Its contour is quite unlike that of *S. perpusilla*, which also occurred at Diente.

Strebelia berendti (Pfr.).

Texolo, State of Vera Cruz (Rhoads, 1899).

Streptostyla novoleonis Pilsbry. Pl. XLVIII, figs. 3, 3a.

Proc. Acad. Nat. Sci. Phila., 1899, p. 397.

Diente, near Monterey, Nuevo Leon. Types No. 77,153, A. N. S. P. It is rather abundant, and the locality is far to the north of any former record for the genus.

Streptostyla edwardsiana C. and F.

Texolo, Prov. Vera Cruz (Rhoads, 1899).

Mr. Ancey has recently added two more species of this genus, *S. sumichrasti* and *S. clavatula*.[4]

Pseudosubulina berendti (Pfr.).

Jalapa, V. C., in forest.

Pseudosubulina berendti occidentalis Pils. Pl. L, fig. 1.

Proc. Acad. Nat. Sci. Phila., 1899, p. 398.

Uruapam, Michoacan. Types No. 77,161, A. N. S. P.

Pseudosubulina texoloensis Pils. Pl. L, fig. 2.

Proc. Acad. Nat. Sci. Phila., 1899, p. 398.

Texolo, V. C. Types No. 77,104, A. N. S. P. The collection made

[4] *Nautilus*, XVII, p. 56.

by Mr. Rhoads contained several other species of *Pseudosubulina* not yet identified.

STENOGYRIDÆ.

Opeas octonoides (C. B. Ad.)

Antigua, V. C.

Opeas micra (Orb.).

Antigua, V. C.

Opeas rhoadsæ Pils. Pl. L, fig. 4.

Proc. Acad. Nat. Sci. Phila., 1899, p. 399.

Diente, near Monterey, Nuevo Leon. Types No. 77,103, A. N. S. P. The specimen figured measures 3.1 x .7 mm.

Opeas odiosum Pils. Pl. L, fig. 3.

Proc. Acad. Nat. Sci. Phila., 1899, p. 399.

Patzcuaro, Michoacan. Types No. 77,100, A. N. S. P.

Opeas patzcuarense Pils. Pl. L, fig. 5.

Patzcuaro, Michoacan. Types No. 77,151, A. N. S. P.

The specimen figured measures length 3.35, diam. .9 mm.

Mr. Rhoads also collected about a dozen species of minute Stenogyroid snails not yet identified, several of them found in some abundance.

Spiraxis uruapamensis Pils. Pl. L, fig. 9 and the fig. between 9 and 10.

Proc. Acad. Nat. Sci. Phila., 1899, p. 398.

Uruapam, Michoacan. Types No. 77,160, A. N. S. P.

Spiraxis (?) borealis n. sp. Pl. L, figs. 6, 6*a*.

Shell wholly imperforate, very slender and long, regularly tapering to the obtuse summit, thin, whitish-corneous. Sculptured with close vertical thread-like riblets about half as wide as the intervals, or a little more crowded. Whorls 12, convex, separated by deep sutures. Aperture small, ovate, the lip thin and simple; columella thin, concave, passing without angle or notch into the basal margin. Length 10, diam. 2, length of aperture 2 mm.

Diente, near Monterey, State of Nuevo Leon. Types No. 77,166, A. N. S. P.

This species agrees fairly well with the description of *S. acus* Shuttl., from Cordova, V. C., except in the smaller size. That species has not been figured. In sculpture *S. borealis* is not unlike *S. intermedius* Strebel. The generic position is uncertain. Six specimens taken.

Leptinaria mexicana (Pfr.).

Texolo, V. C.

Leptinaria tamaulipensis n. sp. Pl. L, fig. 8.

Shell perforate, ovate-conic, pale yellowish-corneous. Surface finely and closely, irregularly and weakly striate; glossy. Spire straightly conic, the apex quite obtuse. Whorls 5½, convex. Aperture less than half the total length. Columella vertical, reflexed, with a rather small fold in the middle. No parietal lamella. Length 6.8, diam. 3.7 mm.

Tamaulipas, in a cañon about 4 miles west of Victoria, elevation about 3,000 feet. Types No. 85,909, A. N. S. P., collected by Mr. S. N. Rhoads, January 21, 1903.

This species is related to *L. mexicana* and *L. martensi*, but differs from both in wanting spaced riblets. No *Leptinaria* has hitherto been reported from north of Misantla, V. C., so that the range of the genus northward is greatly extended by the discovery of this species. Five specimens were found.

SUCCINEIDÆ.

Succinea tlalpamensis Pilsbry. Pl. XLVIII, figs. 4, 4a.

Proc. Acad. Nat. Sci. Phila., 1899, p. 401.

Near Tlalpam, State of Mexico. Types No. 77,207, A. N. S. P. The figures show the extremes of variation in the type lot.

Succinea tlalpamensis cuitseana Pils.

Proc. Acad. Nat. Sci. Phila., 1899, p. 401.

Lake Cuitseo, near Huingo, Michoacan. Types No. 77,208, A. N. S. P.

Succinea virgata Marts.

Texolo, State of Vera Cruz. Many of the shells want the white rays entirely, and in some others they appear only on the spire.

AURICULIDÆ.

Carychium exiguum mexicanum Pils.

Texolo, State of Vera Cruz, and Diente, near Monterey, State of Nuevo Leon.

LIMNÆIDÆ.

Limnæa attenuata Say.

Tlalpam, near the City of Mexico.

Limnæa columella Say.

Lake near Uruapam, State of Michoacan. Pale yellowish-corneous specimens, about the size of var. *championi* Marts., but somewhat shorter, and of lighter color. The spiral sculpture is well developed

and typical. The species has not before been reported from this part of Mexico.

Limnæa desidiosa Say.

Saltillo, State of Coahuila. The specimens are small, reaching a length of only 7.3 mm., but they seem to me to be typical in all other characters. The species is new to Mexico.

Limnæa palmeri Dall.

Biologia Cent. Amer., Moll., p. 377.

This species has been removed from the *Limnæidæ* by Dall, who refers it to the marine genus *Recluzia*.

Planorbis tenuis Dkr.

Tlalpam, State of Mexico, and Acambaro, State of Guanajuata.

Planorbis tenuis exaggeratus Marts.

Lake Patzcuaro, Michoacan. A large series collected by Mr. Rhoads shows the characters of this subspecies to be remarkably constant. No *P. tenuis* were found in the lake.

Planorbis liebmanni Dkr.

Topo Chico, near Monterey, Nuevo Leon.

ANCYLIDÆ.

Ancylus excentricus Morelet.

Lake La Prassa, near Uruapam, State of Michoacan.

Ancylus papillaris Martens.

Uruapam, Michoacan; Tlalpam, State of Mexico; Monterey, Nuevo Leon. This gives this well-characterized species a wide distribution. It has heretofore been known only from Rio Ameca, State of Jalisco.

An *Ancylus* similar to *haldemani* was taken at Monterey, one specimen.

PHYSIDÆ.

Physa osculans Hald.

Tlalpam, State of Mexico; and in the State of Michoacan at Morelia; Lake La Prassa, near Uruapam; Lake Cuitseo, near Huingo; also from a hot spring near the same place, and a ditch near Lake Patzcuaro. Acambaro, State of Guanajuata.

Physa osculans rhyssa Pils.

Proc. Acad. Nat. Sci. Phila., 1899, p. 401.

This form is much smaller than *P. o. plicata* C. and F. Saltillo, Coahuila, and Topo Chico, near Monterey, N. L.

Physa osculans patzcuarensis Pils.

Proc. Acad. Nat. Sci. Phila., 1891, p. 323, Pl. XV, fig. 5.
Physa mexicana var. *coniformis* Strebel, Beitrag I, p. 52 (1873). Not *Physa coniformis* Tryon (1866).

Lake Patzcuaro (Rhoads, 1899). Numerous specimens were taken like the types collected by Heilprin. At the time I described the latter I was not aware of the previous description of the same form by Strebel. He used a preoccupied name which laid in ambush in a dense thicket of text.

Physa berendti Dkr.

Texolo and near Jalapa, State of Vera Cruz.

Physa lacustris Clessin.

At Texolo, State of Vera Cruz, in a small stagnant pond, and under a cascade, a very short-spired *Physa* occurred which seems identical with Clessin's species. The specimens from the small pond reach a length of 10 mm., and are much eroded, having lost most of the cuticle. Those from under the cascade are 6 to 7½ mm. long, and more globose. It seems to be a well-marked species.

Clessin gives "*Centralamerika, See Coatepeque,*" as the locality. There is a Coatepeque in western Guatemala; but Dr. von Martens says "E. Mexico: Lake Coatepec," probably the correct locality.

VALVATIDÆ.

Valvata humeralis Say. Pl. LII, figs. 9, 12, 12*a*.

V. humeralis Say, N. H. Diss., II, 244, Martens, Biologia Cent. Amer., Moll., p. 426.
V. humeralis Say (*humerosa* Say), Strebel, Beitrag I, p. 33, Pl. 4, fig. 42 (not good).
V. strebeli Crosse and Fischer, Miss. Scient. au Mex., Moll., II, p. 304 (based upon preceding reference).

Say's type specimen is here drawn (figs. 12, 12*a*). It agrees with specimens before me from the city of Mexico (Heilprin expedition), and from Lake Xochimilco (fig. 9) in the valley of Mexico[5] (E. D. Cope, 1885). The figures given by Strebel show a raised, acute apex, but as he expressly states that the apex is obtuse, I suppose these figures to be incorrectly drawn. It may be added that Strebel's description agrees fully with some specimens of *V. humeralis*. This being the case *V. strebeli* C. and F., based solely upon Strebel's account, will become a pure synonym of *V. humeralis*. Prof. v. Martens has already treated it as a variety of that species. It may further be noted that Messrs. Crosse and Fischer had seen neither *V. humeralis* nor the form they

[5] Lake Xochimilco is the west end of Lake Chalco, from which it has been artificially separated.

call *V. strebeli*, but base their conclusions upon the published descriptions only. *V. humeralis* varies somewhat in the amount of flattening below the suture, but that character is always noticeable, and the early whorls often appear angular in the middle on account of it. The striation is rather irregularly developed, but always low, never sharp as in *V. sincera*. Some specimens show a few very low subobsolete spiral cords or threads near the periphery of the last whorl, but these are exceptional. The base is indistinctly subangular around the umbilicus. Measurements are as follows:

Alt. 4.2, diam. 5.2 mm., whorls 3¾ (L. Xochimilco).

Alt. 4, diam. 5 mm., whorls 3½ to 3¾ (Strebel).

Alt. 3.2, diam. 4.7 mm., whorls 3½ (L. Xochimilco).

Alt. 3, diam. 4 mm., whorls 3½ (Say's type).

I have treated this species at some length, because, with the exception of Strebel, none of the writers upon this fauna have seen specimens of *Valvata* from Mexico.

Valvata humeralis pilsbryi Martens. Pl. LII, figs. 5, 5a.

Valvata humeralis, specimens from Lake Patzcuaro, Pilsbry, Proc. Acad. Nat. Sci. Phila., 1891, p. 326.
Valvata humeralis var. *pilsbryi* Martens, Biologia, p. 427, September, 1899 (based upon the preceding reference).
Valvata humeralis var. *patzcuarensis* Pilsbry, Proc. Acad. Nat. Sci. Phila., 1899, p. 392 (October 5, 1899).

This form is smoother and more elevated than *V. humeralis*, but still has an obtuse summit; the subsutural flattening of that species, while noticeable on the spire of this, is minimized on the last whorl; and, finally, the umbilicus is narrower, in specimens of the same diameter.

Alt. 5.1, diam. 5 mm., whorls slightly over 4.

Alt. 4.3, diam. 5 mm., whorls 3¾.

Alt. 4, diam. 4 mm., whorls 3½.

Lake Patzcuaro, Michoacan. Several hundred specimens were taken by Mr. Rhoads in 1899. All were collected dead but in good condition, covered with a light brown cuticle. A few of the freshest are of a rather bright green color.

Types of this variety are No. 61,444, A. N. S. P., collected by Heilprin and Baker in 1890. The varietal name *patzcuarensis* was proposed by me before Prof. von Martens' work on the same form reached America, but it is apparently of later date, if the signature lines of the *Biologia* indicate the actual dates of publication.

AMNICOLIDÆ.

Pyrgulopsis patzcuarensis Pilsbry. Pl. LII, figs. 6, 7, 8.

The Nautilus, V, p. 9, May, 1891; Proc. Acad. Nat. Sci. Phila., 1891, p. 330, Pl. 15, fig. 8.
Mission Scient. au Mex., Moll., II, p. 277.

Lake Patzcuaro, Michoacan, the type locality. This was originally described from mutilated examples. A series of over 60 specimens taken by Mr. Rhoads in 1899 enables me to complete the description and to illustrate perfect shells. All are empty shells, and I am therefore unable to examine the dentition, to ascertain whether the species is a true *Pyrgulopsis* or a *Potamopyrgus*.

All of the shells agree in having the first two whorls smooth and convex. Then a strong median keel sets in, continuing 2½ or more whorls, and there is also a minor keel which may be visible just above the suture or concealed by the next whorl. Both keels usually become weaker, mere angles on the last whorl or more, or they may completely disappear, leaving the whorl rounded. The keel is always even and smooth. There are nearly 7 whorls in full-grown shells. The aperture is regularly ovate; the outer lip is sinuous, being retracted above. The largest shell measures, length 7.7, diam. 3.2 mm.

I have seen some thousands of specimens of *Potamopyrgus* from Texas, Mexico and Central America, Venezuela and the West Indies, embracing a great variety of forms; but I have not seen this particular type of shell except from Lake Patzcuaro. It seems to me to be a reasonably distinct species. The form called *Amnicola coronata* var. *unicarinata* by von Martens[6] is not an uncommon variation in the spinose *Potamopyrgus*, and like the smooth, ecarinate phase, it is not a racial or subspecific modification, nor is it sexual, for I have found the unborn young in smooth, carinate and spinose shells, when opening them for the radulæ. American species of *Potamopyrgus* are dimorphic or trimorphic, like some butterflies, owls, etc.

The genus *Potamopyrgus* is amply distinguished from *Amnicola* by its viviparous reproduction, *Amnicola* being oviparous. I fail to see the advantage of lumping them as some recent authors have done.

Chondropoma martensianum Pilsbry. Pl. LII, figs. 4, 4*a*.

Nautilus, XIII, p. 140 (April, 1900).

Mountains of Poana, Tabasco (José N. Rovirosa). Illustrations are now given of the type of this species, which has not before been figured.

[6] *Biologia*, p. 433, September, 1899.

Amnicola panamensis Tryon. Pl. LII, fig. 11.

Proc. Acad. Nat. Sci. Phila., 1863, p. 146.

The type of this species is a single specimen from Panama, collected by Capt. Field, U. S. N. It is of the whitish-corneous color of *A. cincinnatiensis* Anth., has 4½ whorls which are very convex below the sutures, and the axis is perforate. It is extremely similar to *A. cincinnatiensis*, but differs in being only about half the size of well-grown examples of that species. Length 3.4, diam. 2.7, longest axis of aperture 1.8 mm.[7]

An entirely different species collected by Prof. Ralph Tate in Nicaragua was subsequently referred to *A. panamensis*, and this erroneous extension of the range of the species has naturally been repeated in the *Biologia*.

Amnicola tryoni n. sp. Pl. LII, fig. 10.

Amnicola panamensis Tryon, Tate, American Journal of Conchology, V, p. 153.

Shell openly perforate, ovate-conic, thin, corneous and somewhat translucent, the surface smooth, scarcely showing growth striæ. Spire conic, the apex slightly obtuse. Whorls 4½, those of the spire very convex below the suture, the last whorl not swollen there. The aperture is of the usual ovate contour, subangular above; peristome adnate to the preceding whorl for a short distance above. Length 2.3, diam. 1.6, longest axis of aperture 1.2 mm.

Nicaragua, at the roots of plants in a swampy pool near Javali, in the Chontales district, at an elevation of 1750 feet. Types No. 58,066, A. N. S. P., collected by Ralph Tate.

The specimens are encrusted with a ferruginous deposit, so thick as to materially alter the shape of the shell. The one figured has been cleaned. It seems to be closely related to *A. guatemalensis* Crosse and Fischer,[8] from Lake Amatitlan; but *A. tryoni* is a smaller species, with more convex whorls, smoother surface and a more prominent spire. *A. guatemalensis* is not known to me by specimens. *A. stolli* Martens[9] seems also to belong to the same group of species, but it is more conic than the others mentioned above, the last whorl being dilated peripherally, according to Prof. von Martens' figures.

HELICINIDÆ.

Helicina turbinata Wiegm.

Antigua, State of Vera Cruz.

[7] I have every reason to believe this specimen, marked in Tryon's own hand, to be the original type, although it does not agree with the original measurements.

[8] *Miss. Scient. Mex.*, Moll., II, p. 264.

[9] *Biologia Centr. Amer.*, Moll., p. 645.

Helicina succincta Martens.

Texolo, V. C.

Helicina orbiculata tropica Jan.

Monterey, State of Nuevo Leon. Similar to Texan examples.

Helicina fragilis Morel.

Antigua, State of Vera Cruz.

Helicina lirata Pfr.

Antigua, V. C.

Helicina sowerbyana Pfr. Pl. LIV, figs. 7, 8.

Cañon 4 miles west of Victoria, Tamaulipas. Twelve specimens of this fine species, measuring 18 to 21 mm. diam., were taken, the first since the original lot many years ago. I am much inclined to doubt the locality "Guatemala" of the Cumingian type specimen, as the snails of that country are mainly of different species from those of Tamaulipas, and no specimens of this large and conspicuous species have been found in the intermediate territory, part of which is the most fully explored portion of Mexico. *H. sowerbyana* probably does not range south as far as the State of Vera Cruz. The rather conspicuous spiral sculpture does not show in the photographic figures.

Helicina zephyrina Duel.

Texolo, at the falls, State of Vera Cruz.

Helicina zephyrina var. **dientensis** n. v.

Similar to *zephyrina*, except that the body-whorl is more depressed and the base less convex.

Alt. 14.5, diam. 11 mm.

Alt. 12, diam. 9.5 mm.

Alt. 14.3, diam. 11.4 mm.

Diente, near Monterey, N. L. Types No. 77,238, A. N. S. P.

Trochatella simpsoni Ancey. Pl. XLIX, fig. 4.

Annales de Malacologie, II, p. 253.

One of the original specimens, from the series of Utilla shells presented by Mr. C. T. Simpson, is figured. This is the only *Trochatella* known from the mainland of Mexico or Central America or islands adjacent thereto. It was collected on Utilla Island, off the north coast of Honduras, by Mr. Simpson. The shell figured measures 2.6 mm. diam. and alt.

Schasicheila fragilis Pilsbry. Pl. LI, figs. 7, 7*a*.

Proc. Acad. Nat. Sci. Phila., 1899, p. 391.

Diente, near Monterey, State of Nuevo Leon. Types No. 77,237, A. N. S. P.

Since the publication of my description I have obtained specimens of *S. minuscula* (Pfr.), one of which is figured for comparison (Pl. LI, fig. 3). *S. fragilis* is much more depressed than *minuscula*, with more distinct spiral lines when the hairs are rubbed off. The two species are quite distinct.

Schasicheila vanattai Pils. Pl. LI, figs. 5, 5*a*.

Proc. Acad. Nat. Sci. Phila., 1899, p. 391.

Same locality as the preceding, with which it occurred. Readily distinguished by the strong peripheral angle. The sinus is slightly deeper than in *S. fragilis*.

Schasicheila vanattai tricostata subsp. nov. Pl. LI, fig. 4.

Last whorl with three large obtuse rounded carinæ or spiral ribs, the surface concave between them and below the lower one; cuticular spirals weakly developed. Pale yellowish-corneous. Whorls 3½. Alt. 3.7, diam. 4.5 mm.

Cañon 4 miles west of Victoria, Tamaulipas. Type No. 85,908, A. N. S. P.

One adult and one immature specimen collected. In the absence of a series sufficient to show whether the remarkable features above described are constant, I prefer to rank this as a variety of *S. vanattai*. No other known *Schasicheila* has spiral ridges and sulci of this kind.

Schasicheila hidalgoana Dall. Pl. LI, figs. 8, 8*a*.

Schazicheila hidalgoana Dall., Nautilus, XI, p. 62.

Shell depressed, conoidal above, convex beneath, strongly angular at the periphery. Yellowish-corneous, usually pink toward the apex, under a thin brown cuticle, which is very densely and minutely roughened by close cuticular spiral threads, conspicuously longer ones fringing the periphery. These cuticular processes hold sufficient dirt to make the whole surface of fresh shells blackish. Under the cuticle the surface is glossy, striatulate obliquely, and densely striate spirally, Whorls 4½, slightly convex, the intermediate ones with an impression above the suture. Last whorl wide, strongly angular peripherally, a little impressed in the middle of the base. Aperture of the usual half-rotund shape, the outer lip narrowly expanded, with a deep triangular excision or notch above. Umbilical pad small and somewhat sunken. Operculum with processes projecting beyond the lip at both base and upper sinus; bluish gray, indistinctly roughened externally.

Alt. 9, diam. 14 mm.

Alt. 8.7, diam. 12.3 mm.

Cañon 4 miles west of Victoria, State of Tamaulipas. No. 85,919, A. N. S. P., collected by S. N. Rhoads, 1903.

A large series was collected. It resembles *S. vanattai* in shape, but is about double the linear dimensions of that species, and has a proportionally larger lip notch or sinus. In *S. nicoleti* the periphery is less strongly angular, the spiral liræ more widely spaced and the operculum sharply granulose externally. The specimens have been compared by Prof. W. H. Dall with the unique type of his *S. hidalgoana* from Encarnacion, Hidalgo, and pronounced to be identical. Since that species was described from a dead, bleached specimen, I have given a new description of a fresh shell, and figures of a specimen from near Victoria.

SPHÆRIIDÆ.

Crosse and Fischer have shown that the species of *Sphærium* known from Mexico fall into three subgenera: *Sphærium s. str.*, *Musculium* Link (*Calyculina* Cless.), and *Eupera* Bgt. The third group has been raised by von Martens to generic rank. No species of *Eupera* was taken by Mr. Rhoads, but the other groups mentioned are represented in his collection by numerous forms, the study of which necessitates some revision of the group.

The following Mexican and Central American species have been admitted in the *Biologia Centrali Americana:*

S. triangulare Say.
S. subtransversum Pme.
S. martensi Pils.
S. luridum Marts.
S. costaricanum Marts.

The last-mentioned species is not known to me by specimens. From the description and figures it seems to be very different from the others, and a good deal like a *Pisidium.*

The other Mexican species are very well characterized and readily distinguishable. They may be tabulated as follows:

a.—Shell very thin and fragile, delicately striate; beaks usually showing a distinctly defined prodissoconch.
  b.—Shell oblong, the alt. about three-fourths the length, diam. half the length or less, ... *S. subtransversum.*
  b′.—Shell subrotund, the alt. exceeding three-fourths the length, diam. more than half the length, ... *S. novoleonis.*
a′.—Shell varying from thin to moderately strong, striate or costulate, without distinct prodissoconch.
  b.—*Beaks regularly costulate.* Alt. more than three-fourths the length; diam. decidedly over half the length; hinge-line more arcuate than the basal margin; solid, with stout lateral teeth and rather coarse sculpture, . . . *S. triangulare.*

b′.—Beaks nearly smooth; alt. about three-quarters and diam. about one-half the length of the shell; basal and hinge margins about equally arcuate; finely striate.

c.—Subequilateral, the two ends almost equally rounded; olivaceous-gray, with chestnut beaks and usually yellow basal margin, ... *S. jalapensis.*

c′.—Inequilateral, the posterior end noticeably wider; yellow, becoming fleshy-gray at the beaks; thinner, *S. martensi.*

Sphærium triangulare (Say). Pl. LIII, figs. 4, 4a.

Figures are here given of one of the two type specimens of this species (Pl. LIII, figs. 4, 4*a*). It measures, length 13, alt. 10.3 mm., agreeing with Say's measurements.[10] The sculpture of concentric ridges or coarse striæ is strong and a little irregular. *The beaks are strongly, regularly sculptured*, as in *S. striatinum*. This is a very characteristic feature of the species. The beaks are nearly median; the dorsal margin of the valve is much more arcuate than the ventral, and the anterior end tapers somewhat, the posterior being broadly rounded. The anterior and posterior lateral teeth are of about equal length, single in the left, double in the right valve. The anterior pair is decidedly heavier than the posterior, the latter being finely crenulated.

The types are both dead, and have lost the cuticle, but are otherwise well preserved. They are probably from one of the lakes near the City of Mexico, as there is a tray of specimens in the collection exactly like them and in the same condition, from Lake Texcoco.

In Lake Patzcuaro, Michoacan, the shells are smaller but somewhat thicker (Pl. LIII, figs. 3, 3*a;* Pl. LIV, fig. 2). The cuticle is very glossy, bright greenish-yellow with some gray streaks, or gray-brown with or without a yellow zone below. Sculpture as already described, but in these fresh shells some indistinct radii are visible. The beaks are large and full. The ligament, though largely immersed, is conspicuous externally. There is a narrow, slightly sunken escutcheon and a wide, short, lunule bounded by faintly impressed lines. The teeth (Pl. LII, fig. 3, right valve) of this form are a trifle heavier than in typical *S. triangulare*, but otherwise similar. On the right valve the lower laterals seem to be borne on ridges running out from under the hinge-plate. They are very short, high and triangular. Length 11.5, alt. 9, diam. 7 mm.

[10] Prime expressed doubt about the specific identity of the two specimens given to the Academy by Mrs. Say after Say's death, solely because the shell is not especially triangular; but since these specimens agree completely with the original description and measurements, and were labeled by Say, there seems to be no good reason for doubting their authenticity.

Specimens from Acambaro, State of Guanajuato, are similar, two measuring: length 12, alt. 9, diam. 7 mm., and 10.2, 8, 6 mm.

The species described from Ameca, Jalisco, under the name *S. luridum* Marts.[11] seems to be very near *S. triangulare,* if not actually identical therewith.

Sphærium martensi Pilsbry. Pl. LIII, figs. 2, 2a: Pl. LIV, fig. 4.

Proc. Acad. Nat. Sci. Phila., p. 401, 1899. Biologia, p. 552.

When cleaned of the ferrous deposit which coats this shell, it is light yellow, becoming pinkish-gray in the neighborhood of the beaks. The sculpture is a very fine, sharp striation over the lower two-thirds, the beaks being nearly smooth, with minute, glossy tips, sometimes slightly marked off by a barely perceptible depression. The differentiation of the prodissoconch seems hardly tangible enough to warrant a reference of the species to the subgenus *Musculium,* and, moreover, the shell while thin is not fragile as in *Musculium.*

The cardinals are double in the right valve (Pl. LII, fig. 2), as well as the laterals. The latter are rather small and low, and not crenulate. In the left valve the lateral teeth are single. The shell is less solid than *S. triangulare,* but decidedly stronger than *S. subtransversum.* It does not seem very closely related to any other species. Length 15.6, alt. 11, diam. 7.7 mm.

Known only from the type locality, Tzintzuntzan, Lake Patzcuaro, State of Michoacan.

Sphærium jalapensis n. sp. Pl. LIII, figs. 1, 1a; Pl. LIV, fig. 3.

Shell oval, somewhat compressed, the diameter about half the length; ends almost equally rounded, but the anterior is a little more narrowly so; upper and basal margins equally arcuate; beaks projecting but slightly above the dorsal margin; glossy, finely, irregularly striate, and very minutely rugose or subgranulate. There are also obscure radii visible in a suitable light. Olivaceous-gray with a yellow border, and fully adult shells are bright chestnut-colored toward the eroded apices. Escutcheon narrow, lanceolate and perceptibly flattened or excavated; lunule indistinct. Interior bluish-white.

Right valve (Pl. LII, fig. 1*a*) with a small, oblique, bifid anterior and minute posterior cardinal tooth; anterior laterals double, strong, elevated and triangular; posterior laterals double, more slender and crenulate. Left valve (Pl. LII, fig. 1) with a bifid posterior and small simple anterior cardinal; laterals single, the anterior short, high and triangular; posterior lateral single, more compressed.

[11] *Biologia Centr. Amer.,* Moll., p. 552.

Length 14.5, alt. 11, diam. 7.2 mm.

Length 13.2, alt. 10, diam. 6.4 mm.

Pond at Jalapa, State of Vera Cruz. Types No. 77,191, A. N. S. P., collected by S. N. Rhoads, 1899.

This species is most nearly related to *S. sulcatum* (Lam.), but it differs in the following respects. *S. jalapensis* is more compressed and greater in altitude; it is more finely sculptured and more glossy. The lateral teeth are less elevated. The outline of *S. jalapensis* is less angular than that of *S. rhomboideum*. *S. luridum* Martens, from the State of Jalisco, is much smaller, about the size of a half-grown specimen of this species. The teeth are figured as very stout, but from the description they would seem to be not very unlike those of *S. jalapensis*. *S. fabale* is at once distinguished from all these species by its broad, peculiarly compressed shape.

In the specimen figured (Pl. LII, figs. 1, 1*a*) the anterior lateral teeth are reversed. In all others examined they are as described above.

Sphærium (Musculium) subtransversum Prime. Pl. LIII, figs. 6, 6*a*, 6*b*; Pl. LIV, fig. 5.

Prime, Proc. Zool. Soc. Lond., 1860, p. 322; Monogr. Am. Corbiculidæ, p. 62; Sowerby, in Conch. Icon., XX, f. 38. Not *S. subtransversum* Crosse and Fischer, Moll. Mex., II, 652.

Tlalpam, State of Mexico; Morelia, Michoacan (Rhoads).

This is an elongate, fragile species with distinctly "calyculate" beaks; gray, with a yellow zone below. The surface is shining and very finely delicately striate. The upper and lower margins are about equally arcuate, and the anterior end is more tapering than the wider posterior end. The right valve has two diverging cardinal teeth and double laterals (fig. 6*a*); the left valve has a single cardinal and single laterals. The large specimen figured, from Tlalpam, measures: length 15, alt. 10.8, diam. 7.5 mm., but most of the lot are smaller, length about 11 mm. An average shell from Morelia measures: length 9.3, alt. 7, diam. 4.2 mm.

In my opinion the figures given by Crosse and Fischer do not represent this species. The dimensions given by Prime are: length .30, alt. .20, diam. .10 inch. These must have been taken from a quite young shell, but certainly it was lower and more compressed than Crosse and Fischer's *subtransversum*, which measured: length 10.5, alt. 8.5, diam. 6 mm. The figure given by Sowerby, while too small to show any details, yet agrees with Prime's description in contour.

Sphærium (Musculium) novoleonis n. sp. Pl. LIII, figs. 5, 5*a*, 5*b*; Pl. LIV, fig. 6.

Shell fragile, short and rather globose, the diameter slightly more than half the length; thin; anterior end rounded, posterior end wider,

obliquely subtruncate; upper and lower margins subequally arcuate; beaks full and prominent, with rather indistinct "caps"; lunule and escutcheon are not differentiated. Surface glossy, finely and rather obsoletely striate. Yellowish-gray. Interior bluish-white. Right valve (Pl. LIII, fig. 5), with two small diverging cardinal teeth, and double anterior and posterior laterals, the former stouter. Left valve with the cardinal tooth small, the laterals single.

Length 11, alt. 9, diam. 6 mm.

Monterey, State of Nuevo Leon. Types No. 77,190, A. N. S. P., collected by S. N. Rhoads, 1899.

This species is similar to *S. partumeium* in general characters. The beaks are not distinctly capped as in that species, and the anterior lateral teeth are shorter and much closer to the cardinal.

In my opinion the shells figured by Crosse and Fischer as *S. subtransversum* belong to this species.

Pisidium abditum Hald.

Lake Prassa, near Uruapam, and Tlalpam, State of Mexico; Texolo, State of Vera Cruz (Rhoads); also Orizaba, V. C. (Heilprin expedition). These localities go far to connect the Central American range given by v. Martens with the range of the species in the United States.

UNIONIDÆ.

Unio plexus Conrad.

Vera Cruz, State of Vera Cruz.

Lampsilis umbrosus (Lea).

Vera Cruz, V. C.

Lampsilis rovirosai Pils. Pl. LIV, figs. 1, 1a.

Nautilus, XIII, p. 140 (April, 1900).

Laguna de Atasta, near San Juan Bautista, State of Tabasco, collected by Sr. Ing. D. José N. Rovirosa, a naturalist of Tabasco, especially interested in botany, whose death, December 23, 1901, I regret to record. The figures are natural size, from photographs of the type. No. 58,916, A. N. S. P.

REFERENCE TO PLATES XLVII–LIV.

Plates XLVII to LIII were drawn with camera lucida by Miss Helen Winchester; plate LIV was reproduced from photographs.

PLATE XLVII, Figs. 1, 1a—*Glandina michoacanensis* Pils.
Fig. 1b.—New-born young of the same.
Figs. 2, 2a, 2b.—*Glandina huingensis* Pils.
Figs. 3, 3a, 3b.—*Glandina rhoadsi* Pils.
Figs. 4, 4a, 4b.—*Glandina victoriana* Pils.
Figs. 5, 5a.—*Glandina dalli* Pils.

Fig. 6.—*Glandina oblonga tamaulipensis* Pils., young shell.
Figs. 6*a*, 6*b*.—*Glandina oblonga tamaulipensis* Pils.

Plate XLVIII, Figs. 1, 1*a*, 1*b*.—*Glandina delicata* Pils.
Fig. 2.—*Glandina delicata alticola* Pils.
Figs. 3, 3*a*.—*Streptostyla novoleonis* Pils.
Figs. 4, 4*a*.—*Succinea tlalpamensis* Pils.
Figs. 5, 5*a*, 5*b*.—*Omphalina montereyensis victoriana* Pils.
Figs. 6, 6*a*, 6*b*.—*Omphalina montereyensis* Pils.
Figs. 7, 7*a*, 7*b*.—*Omphalina martensiana* Pils.

Plate XLIX, Figs. 1, 1*a*, 1*b*.—*Pyramidula victoriana* Pils.
Figs. 2, 2*a*.—*Thysanophora proxima* Pils.
Figs. 3, 3*a*, 3*b*.—*Thysanophora tatei* Pils.
Fig. 4.—*Trochatella simpsoni* Anc. Topotype.
Figs. 5, 5*a*, 5*b*.—*Guppya micra* Pils.
Figs. 6, 6*a*.—*Thysanophora fischeri* Pils.

Plate L, Fig. 1.—*Pseudosubulina occidentalis* Pils.
Fig. 2.—*Pseudosubulina texoloensis* Pils.
Fig. 3.—*Opeas odiosum* Pils.
Fig. 4.—*Opeas rhoadsæ* Pils.
Fig. 5.—*Opeas patzcuarense* Pils.
Figs. 6, 6*a*.—*Spiraxis*(?) *borealis* Pils.
Figs. 7, 7*a*.—*Bifidaria prototypus* Pils.
Fig. 8.—*Leptinaria tamaulipensis* Pils.
Figs. 9, 9*a*.—*Spiraxis uruapamensis* Pils.
Figs. 10, 10*a*.—*Epirobia mirabilis* Pils.

Plate LI, Figs. 1, 1*a*, 1*b*.—*Polygyra suprazonata* Pils.
Figs. 2, 2*a*, 2*b*.—*Polygyra rhoadsi* Pils.
Fig. 3.—*Schasicheila minuscula* Pfr.
Fig. 4.—*Schasicheila vanattai tricostata* Pils.
Figs. 5, 5*a*.—*Schasicheila vanattai* Pils.
Figs. 6, 6*a*.—*Praticolella strebeliana* Pils.
Figs. 7, 7*a*.—*Schasicheila fragilis* Pils.
Figs. 8, 8*a*.—*Schasicheila hidalgoana* Dall.

Plate LII, Fig. 1.—*Sphærium jalapense* Pils., left valve; 1*a*, right valve. Anterior teeth are reversed in this specimen.
Fig. 2.—*Sphærium martensi* Pils. Right valve.
Fig. 3.—*Sphærium triangulare* Say. Right valve. Lake Patzcuaro.
Figs. 4, 4*a*.—*Chondropoma martensianum* Pils.
Figs. 5, 5*a*.—*Valvata humeralis pilsbryi* Marts.
Figs. 6, 7, 8.—*Pyrgulopsis patzcuarensis* Pils.
Fig. 9.—*Valvata humeralis*. Lake Xochimilco.
Fig. 10.—*Amnicola tryoni* Pils.
Fig. 11.—*Amnicola panamensis* Tryon. Type specimen.
Fig. 12, 12*a*.—*Valvata humeralis* Say. Type specimen.

Plate LIII, Figs. 1, 1*a*.—*Sphærium jalapense* Pils.
Figs. 2, 2*a*.—*Sphærium martensi* Pils.
Figs. 3, 3*a*.—*Sphærium triangulare* Say. Lake Patzcuaro.
Figs. 4, 4*a*.—*Sphærium triangulare* Say. Type specimen.
Figs. 5, 5*a*, 5*b*.—*Sphærium novoleonis* Pils.
Figs. 6, 6*a*, 6*b*.—*Sphærium subtransversum* Prime.

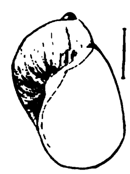
Plate LIV.—Figs. 1, 1*a*.—*Lampsilis rovirosai* Pils.
Fig. 2.—*Sphærium triangulare* Say. Lake Patzcuaro.
Fig. 3.—*Sphærium jalapensis* Pils.
Fig. 4.—*Sphærium martensi* Pils.
Fig. 5.—*Sphærium subtransversum* Pme.
Fig. 6.—*Sphærium novoleonis* Pils.
Figs. 7, 8.—*Helicina sowerbyana* Pfr.

A NEW HAWAIIAN LIMNÆA.

BY HENRY A. PILSBRY.

Limnæa hawaiensis n. sp.

The shell is dextral, very narrowly rimate, obliquely ovate, thin and light brown; surface very closely, finely and distinctly striate longitudinally. The spire is extremely short and obtuse, there being scarcely three whorls in all, separated by a deeply impressed suture. The last whorl is convex below the suture, then slopes outward, and is full and sack-like at the periphery and base. The broad, ovate aperture is oblique and nearly as long as the shell. The columellar lip is reflexed, and indistinctly folded above.



Length 6.5, diam. 5.3, length of aperture 5.5 mm.

Hawaii, in small streams in the mountains on the Hilo side. Types No. 85,380, A. N. S. P., collected by R. C. McGregor in 1900.

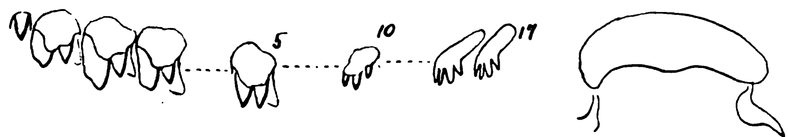
The shell of this species approaches *Erinna newcombi* H. and A. Ad.,[1] described from Hanalei river, Kauai, in contour, but it is evidently more closely related to *Limnæa affinis* Souleyet.[2] That species was described from streams on the island of Oahu, and is said to be "*toujours sénestre*," while every one of the 30 or 40 examples of *L. hawaiensis* taken is dextral. Although Pease claims that some of the Hawaiian species are indifferently sinistral or dextral, it seems to me that the alleged constant sinistral coiling of the Oahu form, and the equally invariable dextral convolution of this form from Hawaii, indicate that the two islands are peopled by separate species of these short-spired Limnæas.

Pease includes *L. affinis* Soul. and *L. "sandwichensis"* Phil. (=*sandwicensis* Phil.) under *L. oahuensis* Soul. as synonyms.[3] It is evident that he had never seen Souleyet's *L. affinis*, or even the figures of it, for it is as remote as possible from *oahuensis*. *L. sandwicensis* Phil. is a much more lengthened species than *L. hawaiensis*.

None of the species described by Pease[4] and by Gould[5] are closely related to *L. affinis* and *L. hawaiensis*.

[1] *Genera of Recent Mollusca*, II, p. 644.
[2] *Voy. Bonite*, Zool., II, p. 528, Pl. 29, figs. 42–44.
[3] *American Journal of Conchology*, VI, p. 5.
[4] Pease, *t. c.*, pp. 5, 6.
[5] *U. S. Exploring Expedition*, Mollusca, Atlas, figs. 140, 142.

The radula has about 15.8.1.8.15 teeth. The central tooth in each row is small and unicuspid. The laterals are bicuspid; the inner ones



have the inner cusp wide and obtuse or slightly emarginate, evidently composed of entocone + mesocone. The two cusps become subequal on the outer lateral teeth. The inner marginal teeth have three cusps, the outer ones four, by splitting of the entocone.

The jaw is arcuate, with small lateral appendages as usual in *Limnæa*. It is smooth.

The teeth of this snail differ from those of Holarctic species of *Limnæa* in the structure of the laterals, but the radula is not that of the *Planorbinæ*. The dentition is known in so few Limnæid species outside of Europe and the United States that no useful comparisons of this peculiar Hawaiian type can be made. The animals as contracted in formalin resemble *Limnæa* externally, having short, wide tentacles and a short foot.

December 15.

The President, Samuel G. Dixon, M.D., in the Chair.

Thirty-four persons present.

The death of Samuel B. Howell, M.D., December 12, 1903, was announced. He was elected a member in 1855, and held the office of Recording Secretary from February, 1867, to December, 1874.

The following was accepted for publication:

SOME PELAGIC POLYCHÆTA NEW TO THE WOODS HOLE FAUNA.

BY J. PERCY MOORE.

The pelagic annelid fauna of southern New England has received but little attention and, with the exception of larval forms, some Sillidæ and the epitokous phases of some nereids, etc., practically nothing relating to it has been recorded. With the exception of *Tomopteris* all of the genera discussed in the following pages are new to the region.

Amphinome pallasii Quatrefages.

From several logs covered with goose barnacles (*Lepas anatifera*) which came ashore in Vineyard Sound on August 4 and 5, 1903, a large number of examples of this species were taken. Most of them measured from 2 to 2½ inches in length, and their size and peculiar bluish-brown color served to conceal them admirably among the stalks of the barnacles and in the crevices to which they clung. Several were observed to squeeze between the valves of barnacles and to feed on their soft parts, and the digestive tracts of others were filled with a soft pasty substance apparently composed of the tissues of those animals.

There can be no doubt that these specimens are of the species described and figured under the above name by Ehlers in his *Florida Anneliden*, and which is probably a regular Gulf Stream waif. Under the name of *A. rostrata* (Pallas) McIntosh[1] describes an *Amphinome* taken from a floating log near the Bermudas. From his description the Woods Hole specimens differ most obviously in having the short notopodial setæ with serrated tips more slender instead of stouter than the longer notopodial setæ, and in the different form of the terminal knobs of the very short spines. The shape of the cephalic caruncle and the arrangement of the setæ also present slight divergences, but in all other respects the resemblance is very close. Prof. McIntosh apparently considers the two species identical.

Hipponoë gaudichaudi Aud. and M. E.

On the same floating logs that yielded the *Amphinome* were found many fine examples of this species, which agree perfectly with the original description and with McIntosh's[2] detailed account and figures.

[1] *Challenger Reports*, XII, p. 21.
[2] *Challenger Reports*, XII, p. 30

Unlike the *Amphinome*, most of these were found on the under side of the logs away from the light, associated with crabs and nudibranches, and less frequently among the barnacles on the sides and upper surface. By means of their strong neuropodial hooks they cling most tenaciously and move very sluggishly. The larger ones were of a deep orange-red color, due to the great number of small spherical ova with which the body wall was distended, and the expulsion of which caused the color to quickly fade.

Again, unlike the *Amphinome*, which is a common annelid in the littoral zone of the West Indies, this species probably finds its normal habitat on floating objects. The original examples of Audouin and Milne-Edwards[3] came from Port Jackson, while the *Challenger* took the species in the Atlantic Ocean, 100 miles north of Bermuda, and also in the North Pacific, in one case attached to a log and in the other among masses of *Lepas fascicularis* floating at the surface. Baird[4] also notes that the British Museum contains specimens taken amongst barnacles on a floating log near Madeira, and others from within the valves of *Lepas fascicularis* from near St. Helena.

Driesohia pellucida n. sp.

This is a slender species, the single representative of which has a total length, including the protruded proboscis, of 14 mm., a maximum breadth of body of about 1 mm., a width between the tips of the parapodia of 2.8 mm. and between the ends of the longest setæ of 6 mm.

The prostomium (Pl. LV, fig. 1) is of the *Lepidonotus* type, is $\frac{3}{4}$ as long as broad, regularly convex laterally, slightly concave posteriorly and deeply cleft anteriorly to accommodate the ceratophore of the median tentacle, on each side of which the frontal prolongations reach nearly to the same distal level; a broad shallow median depression reaches almost to the posterior margin. The eyes are rather small, circular and black, and because of the beautifully transparent tissues very conspicuous; they are well separated on the sides of the head, the anterior pair at the place of its greatest width and the posterior close to the postero-lateral angles and about twice their own diameter from the anterior eyes. The style of the median tentacle is lost. As in *Lepidonotus*, the lateral tentacles arise directly from the frontal processes without any distinct ceratophores; they are about $1\frac{1}{2}$ times the length of the head, very slender and taper regularly to acute points without any subterminal enlargement or terminal filament. The palpi are widely separated at their origin beneath the sides of the prostomium,

[3] *Ann. Sci. Nat.* (1), XX (1830), p. 159.
[4] *Jour. Linn. Soc. Lon.*, X (1868), p. 239.

rather stout at the base, tapered gradually to the terminal fourth and then rapidly to a short filamentous tip; they are about twice the length of the head, and the dorsal surface is marked by two longitudinal ciliated lines. No setæ occur on the buccal parapodium. The ceratophores of the tentacular cirri reach beyond the prostomium; their styles are subequal, more than 4 times the length of the head, slender and regularly tapering to fine tips. Crowded between the bases of the tentacular cirri, the prostomium and first elytrophore on each side is a small ovate lobe. The protruded proboscis measures 1.5 mm. long and .7 mm. wide, is nearly terete and bears 13 acute ovate papillæ (fig. 6) above and a like number below. Just proximad of these is a circular ridge, terminating on each side in a small prominence. No peculiarities are presented by the interlocking fang-like jaws.

Besides the peristomium and pygidium there are 25 very distinct setigerous somites in the slender elongated body (fig. 1), which tapers very gently both ways but quite rapidly near the pygidium. Owing to the very delicate musculature the body walls are thin and inflated and so transparent that even in the alcoholic specimen the entire arrangement of the parapodial muscles is distinctly visible. Except a few at each end, all of the somites are partially biannulate through a cross-furrow just anterior of the parapodia. No nephridial papillæ are visible. The small truncated pygidium is slightly annulated, as though composed of several somites, and bears a pair of minute caudal styles above the somewhat dorsally directed anus.

All of the 25 pairs of setigerous parapodia (figs. 2-5) are uniramal, consisting of neuropodia alone. They are elongated and prominent, those of the middle region very nearly equaling the width of the body. Of a nearly cylindrical form, they are somewhat enlarged at the end, where they terminate in a longer, more pointed presetal process and a shorter, thicker postsetal process, which is rendered slightly less transparent than the rest of the organ by a small aggregation of gland cells. Toward the ends of the body the parapodia diminish in size, and the last one is a mere short, cylindrical tubercle. Ventral cirri occur on all parapodia. They arise from the middle of the ventral surface and are always slender and regularly tapered; on a few of the anterior somites they reach to the tip of the parapodia, but typically are only ⅓ as long as their parapodium.

The dorsal cirri (Pl. LV, figs. 1, 2, 5) are borne on all parapodia not occupied by elytra, and because of their unequal development are very characteristic. Each springs from a slight elevation of the body wall above and slightly caudad of the parapodium. The ceratophores

are subcylindrical, but are somewhat constricted at the base and tapered more or less distally, thin-walled and hollow, with less transparent integuments than the body. Typically they are of large size, many of them much exceeding their parapodia, which they may totally conceal from above. The second (on somite VI) is the largest, being twice as long and much thicker than the corresponding parapodium. The next two are successively slightly shorter; and from this point to near the posterior end large and small cirri regularly alternate, short ones whose ceratophores barely equal the parapodia occurring on XII, XVI and XX, long ones with ceratophores much exceeding the parapodia on XIV and XVIII, that of XXII, though of reduced size, also belonging to the latter group by reason of its long style. On XXIV the dorsal cirri are greatly reduced. The styles are slender and tapering to the ends, those of the larger cirri being whip-lash-like and from 1½ times to twice the length of the ceratophores, and the smaller ones little exceeding their ceratophores and apparently more rigid. The style on XXIV is conical, that of XXV short ovate. Whether somite XXVI bears a cirrus or an elytron is uncertain, as only a small tubercle is present.

Twelve pairs of elytrophores occur on somites II, IV, V, and then on every alternate somite to XXIII inclusive, and the small tubercle on XXVI may possibly indicate a thirteenth. The elytrophores are remarkable for their length and slenderness (figs. 3 and 4). In the alcoholic specimen they are much contracted, as indicated by the wrinkles, furrows and nodules upon their surfaces, particularly of the last two. When the specimen was first taken they were extended, and the parapodia were raised high above the body. The elytra are attached near the middle by a very limited area, and are readily detached. They are perfectly plain and smooth, without papillæ, cilia or processes of any kind, or any pigment. Instead of having the usual scale-like form, the elytra, when the specimen was taken from the tow-net and still alive, were inflated and spherical, being mere thin-walled vesicles filled with fluid, but certainly entirely closed and without any communication with the cœlom. That this condition may have resulted from rough handling in the net is possible, but seems improbable from the fact that every elytron is in the same condition. An area surrounding the scar of attachment is finely granular; elsewhere the elytron is perfectly transparent. A large part of the back is exposed, the elytra having the aspect of a series of floats attached along its sides.

Typical parapodia bear setæ of two kinds, the one elongated and

slender, the other short and stout, but both are essentially of the type found in the neuropodium of *Lepidonotus* and its allies, though the slender ones superficially resemble the notopodial form. Both kinds are colorless and vitreous. The former kind (fig. 7) are arranged in a spreading fan-shaped fascicle, and many of them are exceedingly long and slender, their total length equaling or exceeding the entire transverse distance between the tips of the parapodia. Very frequently the inner ends of those of the two sides of the body touch or even overlap in the cœlom beneath the intestine, and their protruded portions reach beyond the parapodia to a distance equal to or even twice its length. For the greater part of their length they are smooth and of an even diameter, but at a point on the exposed part a variable distance from the end a more or less distinct enlargement occurs, beyond which the seta tapers very gradually into a fine, usually slightly curved tip, the convex margin of which is marked by a series of minute appressed scales. The length of this tip varies greatly even in setæ which are contiguous in the bundle. The shortest setæ of this kind occur in the ventral portion of the anterior bundles and the longest in the middle portion of the posterior bundles. The number is greatest in the middle somites and diminishes each way, the last parapodium having but one in this specimen.

The stout setæ (figs. 9 to 12) recall the form of those of *Scalesetosus*. They are 2 or 3 times as thick as the slender ones and very much shorter. Near the end is a rather abrupt enlargement, beyond which they taper somewhat irregularly into a short, somewhat hooked tip provided in newly formed setæ with a flexible appendage, which in most instances is quickly worn away. On the dorsal side of the thickening is a short transverse fringe, followed along the same or concave side of the tip by 4 or 5 pairs of delicate combs reaching about half-way to the tip. Almost invariably 3 stout setæ are found in the ventral part of the parapodium, and the dorsalmost one only is accompanied by a slender seta. On the first parapodium (II) are a few setæ of an intermediate type (fig. 8); the ventralmost one is the stoutest, the dorsal one most attenuated. The two kinds are well differentiated on III.

The alimentary canal is slender and thin-walled, with regular enlargements at the septa. A few degenerating ova in the cœlom establish the sex. As indicated above the specimen is colorless and pellucid, with distinct pigment in the eyes only.

The only known specimen was taken in the surface tow-net, 70 miles southeast of Nomans Land, Massachusetts, on the border of the Gulf Stream, on July 31, 1902, along with Salpæ, several species of pteropods

and medusæ and other constituents of that strictly pelagic fauna. Though this locality is not strictly within the limits of the Woods Hole region it is frequently visited by expeditions sent out from Woods Hole by the U. S. Fish Commission, and members of its fauna are every summer carried into Vineyard Sound by favorable winds.

The discovery of a species of *Drieschia* in our waters is of exceptional interest, as the type and hitherto only known species of the genus was described by Michaelsen[5] from the neighborhood of Ceylon, and has not been found since. Like the new species, it is pelagic and pellucid, but differs decidedly in specific characters. *D. pelagica* has 28 somites and 13 pairs of elytra; the palpi are as long as the tentacular cirri and 2½ times the antennæ; the dorsal cirri are all alike and have very thick but short ovate ceratophores, and the stout setæ are strongly curved and of a quite different shape. The elytra have the same peculiar inflated character described for *D. pellucida*, though apparently less pronounced.

Tomopteris helgolandica Greef. ?

Several specimens of a perfectly limpid species of *Tomopteris* were taken in the tow-net, lowered nearly to the bottom in 17 fathoms, at Crab Ledge, east of Chatham, Massachusetts, on August 19, and again on August 22, 1902. The same species was also taken at the surface at Woods Hole in July, 1903. Prof. Verrill has recorded the occurrence of the young of *Tomopteris* in Vineyard Sound,[6] and an unidentified species of the genus from the Gulf Stream material collected by the *Albatross* in 1883.[7] These appear to be the only published records of the capture of this interesting annelid in this region. Miss Katharine Bush has kindly compared one of my specimens with those from the Gulf Stream in the Yale Museum, and states that they are of the same species, a conclusion which I am enabled to confirm through Prof. Verrill's courtesy in sending to me an unpublished drawing of his species.

After a careful examination of the very considerable literature of the genus I am still in doubt concerning the identity of the Massachusetts examples. Notwithstanding Apstein's excellent monographic work,[8] there are still wanted careful descriptions of the changes undergone by many of the species during growth and of the very considerable variations which occur among the mature worms, of the limits of which

[5] *Mitteilungen Naturhis. Mus. Hamburg,* IX (1891), p. 6.
[6] *Invertebrates of Vineyard Sound,* p. 332 (626).
[7] *Rep. U. S. Fish Commission for 1883* (1885), p. 594.
[8] *Alciopiden und Tomopteriden der Plankton Expedition.*

but little is known. From all of the species which have been accurately described, with the single exception of that to which Greeff has given the name of *T. helgolandica*, the Massachusetts form is clearly differentiated. *T. helgolandica* it resembles closely in all of those technical characters, such as the distribution of rosette-organs and parapodial fin glands, the form of the parapodia, relative length of the cirri, etc., which have been most relied upon for the discrimination of species by the best students of this group—Apstein, Greeff and Vejdovsky.

On the other hand there are many minor points of difference, most of which are constant in the 8 specimens at hand, but which are of such a nature that they may be temporary or local, and not specific. The specimens vary in length from 6 mm., in one having 10 pairs of parapodia, to 18 mm., in one having 16 pairs of parapodia besides a caudal appendage of 3 mm. on which occur 8 additional pairs. These and the intermediate growth stages exhibit the changes in the proportions of cirri, etc., which have been described by Carpenter and others. In all except the largest example the rosette-organs are limited to a single one situated in the broad fin membrane near the apex of each ramus of the foot, exactly as in *T. helgolandica*, but the largest specimen only possesses the third one on the anterior side of the base of the neuropodia of the first and second feet, generally present in that species. In these the dorsal ramus of the parapodia (fig. 13) is the longer, while *T. helgolandica* is always figured as having the ventral ramus longer. The fin membranes and the neuropodial gland exhibit no differences. The 4th and 5th parapodia are the longest, and all except the first two have their finned ends turned sharply caudad. Differences in the shape of the prostomium, which has a more slender median part and longer horns, in the shape of the base of the second pair of cirri, which has an anterior shoulder, and a longer interval between the second pair of cirri and the first parapodia may be due to a different state of contraction of the preserved specimens. In all, excepting the second, of these respects the resemblance to the figures of *T. rolasi* Greeff is closer. The Woods Hole specimens were collected by Mr. Edwards, and were studied only after preservation in formaline, but no red or yellow pigment was apparent. The Crab Ledge specimens while alive had no red pigment, and the central body of the rosette-organs was brown and not yellow; moreover, these organs appear to have a less regular structure than in *T. helgolandica*, but for the study of these, as well as the lenses of the black-pigmented eyes, and the brain, fresh material is required.

In all of the specimens the alimentary canal largely fills the cœlom,

the muscular pharynx reaches nearly or quite to the first parapodium and, except in two or three, the proboscis is everted and has the shape of an elliptical dish. Ovaries are present in both rami of developed parapodia, arising from near the apex of the outer wall, and are actively proliferating spherical groups of ova and nurse-cells, many of which float freely in the cœlom. There is little indication of the predominance of one cell in each of these groups, so that none of the specimens shows evidence of approaching maturity.

From the foregoing it is evident that the specific identity of our species with that so well known from northern European waters under the name of *T. onisciformis* Eschscholtz is by no means certain. Greeff's name is employed in the belief that future more thorough knowledge of the species of this genus will probably justify it, though the grounds[9] upon which he splits Eschscholtz's species into two and altogether abandons the latter's much earlier name[10] are quite insufficient. Southern New England is within the already known geographical range of *T. helgolandica*. In the western Atlantic Apstein found it abundantly in the plankton taken off Newfoundland, and records it from as far south as the mouth of the Amazon river. *T. smithii* Verrill[11] from Eastport, Maine, is probably founded on adult examples of this species, and if the black spots shown at the bases of the parapodia of the West Indian *Tomopteris* figured by Agassiz[12] represent the nephridial pores, there is no apparent reason for considering that to be any other species. By far the most generally distributed species in the warmer parts of the western Atlantic, according to the records of the German Plankton Expedition, is *T. keferstinii*, but no American planktologist has recorded this from the surface fauna of the Gulf Stream. Andrews[13] states that immature individuals of a *Tomopteris* resembling *T. rolasi* occur at Beaufort, North Carolina, but no description of them has been published.

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[9] *Zeit. f. wiss. Zool.*, XXXII, p. 264.
[10] *Isis*, 1825, column 736, Pl. 5, fig. 5.
[11] *Proc. U. S. Nat. Mus.*, II (1879), p. 182.
[12] *Three Voyages of the Blake*, Vol. I, p. 192.
[13] *Proc. U. S. Nat. Mus.*, XIV (1891), p. 300.

Explanation of Plate LV.

Figs. 1 to 12.—*Drieschia pellucida.*

Fig. 1.—Dorsal view of entire worm with the elytra removed. × 11.

Figs. 2 to 5.—Parapodia of somites X, IV, IX and XIV respectively, viewed from the posterior face, XIV only with the setæ. × 24.

Fig. 6.—Front view of the proboscis, showing jaws and papillæ. × 56.

Fig. 7.—One of the shortest of the slender setæ from the ventral margin of somite XIV. × 250. *a*, a small portion of the same. × 440.

Fig. 8.—Face view of a seta from the middle of the first parapodium (II). × 360.

Figs. 9 to 11.—The tips of three stout setæ from somite X, 9 having the pennant-like tip, 10 the most ventral and 11 the most dorsal of the group. × 360.

Fig. 12.—Face view of a stout seta with tip intact from somite XIV. × 360.

Fig. 13.—Outline of a typical parapodium (V) of a medium-sized *Tomopteris* from Crab Ledge, showing the rosette-organs, *dr* and *vr*, the fin gland, *gl*, and the ovaries, *o*, the latter being represented diagrammatically. × 24.

The following reports were ordered to be printed:

REPORT OF THE RECORDING SECRETARY.

Twenty-eight meetings of the Academy were held since the beginning of last December with an average attendance of thirty. Verbal communications were made by Messrs. Woolman, Harshberger, Palmer, Davis, J. C. Morris, Hamilton, Chapman, Pilsbry, Keeley, Montgomery, Calvert, A. E. Brown, Strong, Taylor, Kennedy, Hopper, Dixon, Sharp, Conklin, DuBois, Philips, Fowler, Strong, and Stone. Without attempting to estimate the comparative importance of these, it may be noted that the remarks of Messrs. Chapman and Brown, made at the meeting of November 3, on the fine collection of anthropoids presented by Dr. Thomas Biddle, attracted the largest assembly of the year.

Fifty-five papers have been presented for publication, as follows: Henry W. Fowler, 7, Henry A. Pilsbry, 5; John W. Harshberger, 4; James A. G. Rehn, 4; T. D. A. Cockerell, 3; Howard Crawley, 3; Ralph V. Chamberlain, 2; Thomas L. Casey, 2; Arthur Erwin Brown, 2; Clarence B. Moore, 2; Thomas H. Montgomery, Jr., 2; J. Percy Moore, 2; Adele M. Fielde, 2; T. Chalkley Palmer, 1; Witmer Stone, 1; Witmer Stone and J. A. G. Rehn, 1; William Morton Wheeler, 1; Henry Skinner, 1; Edw. B. Meigs, 1; Frederick W. True, 1; Nathan Banks, 1; Persifor Frazer, 1; Carl H. Eigenmann and C. H. Kennedy, 1; E. G. Conklin, 1; Dana B. Costeel, 1; J. A. G. Rehn and T. D. A. Cockerell, 1, and E. G. Vanatta, 1.

Three of these (one as yet presented only by title) belong to the *Journal*. Two of those intended for publication in the *Proceedings* have been withdrawn, three have been returned to the authors, one was transferred to the Entomological Section and one has been held for the next volume. The others will constitute the volume for the current year.

Nine hundred and twelve pages of the *Proceedings* for 1903, illustrated by 44 plates, 340 pages and 15 plates of the *Entomological News*, 472 pages and 8 plates of the *Transactions of the American Entomological Society* (Entomological Section of the Academy) and 322 pages accompanied by 62 plates of the *Manual of Conchology*, published by

the Conchological Section, have been issued. In addition we are indebted to Mr. Clarence B. Moore for the publication of No. 3 of Vol. XII of the *Journal*, consisting of 136 pages, profusely illustrated with text engravings.

Under the auspices of the Academy, therefore, there have been issued during the year 2182 pages and 129 plates of scientific matter.

The statistics of distribution are as follows:

PROCEEDINGS, delivered to members,	518
" exchanged,	587
" to subscribers,	45
	1,150
JOURNAL, exchanged,	70
" to subscribers,	34
	104

Thirteen members and five correspondents have been elected. The deaths of seven members and three correspondents have been announced, and the following members have resigned: William H. Roberts, Thomas G. Morton, Charles D. Lippincott, E. Shirley Borden and Miss Ethel Smith.

The most notable event in the year's history was the adoption, May 5, of a revised code of By-Laws, providing for several changes in administration. The most important of these relate to the meetings of the Academy and the duties of the Committee on Publication. Instead of a meeting every Tuesday evening throughout the year, sessions are now held on the first and third Tuesdays from October to May inclusive, thus decreasing the number from fifty-two to sixteen. It was held that the constantly increasing tendency to the division of scientific interests into specialties and the consequent organization of sections and special societies interfered with attendance on general meetings, and that all interests involved would be better secured by meeting less frequently. It is, perhaps, premature to pronounce an opinion on the results of this important change, but it is quite apparent that the interest of the meetings held since last October has been better sustained than for some years previous. The reference of papers direct to the Publication Committee instead of indirectly to the Academy, a change unavoidable in view of the decrease in the number of meetings if promptness of publication were to be secured, has been found in practice to be desirable, as the interval between the reception of a paper and its appearance in print has been much reduced—has been, in fact, reduced as far as seems to be at present practicable, while it is con-

sidered essential that authors should examine, when possible, one proof and frequently a revise. This rule, of course, sometimes involves delay over which the Committee can have only indirect control, but results in such good that there can be no question of its advisability.

A resolution was adopted February 24 requesting the Pennsylvania Topographic and Geologic Survey Commission to survey and prepare maps at an early date of the quadrangles of Coatesville, Phœnixville, Supplee, Oxford and New Holland.

An invitation to meet in Philadelphia during the approaching Christmas vacation has been accepted by the Society of American Zoologists, the American Physiological Society, the Society of Plant Morphologists and Physiologists, the Society of Bacteriologists and the Eastern Branch of the American Society of Naturalists.

A number of the smaller related societies continue to avail themselves of permission to meet in the rooms of the Academy.

The resignation of Dr. Thomas H. Montgomery, Jr., has created a vacancy in the Committee on Instruction and Lectures, and the death of Dr. Charles Schaeffer one in the Committee on Library.

EDWARD J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

Continuing the inquiries begun last year concerning Correspondents whom the postal authorities reported as removed from the recorded addresses, the whereabouts of several have been ascertained during the year. In many cases the reported decease of Correspondents has been authenticated. The assistance of the many persons who furnished biographical and other data in connection with this work is gratefully acknowledged, and especial mention should be made of the War and Navy Departments.

During the year the deaths have been regretfully announced of Augustus Radcliffe Grote, the American entomologist, who had resided for many years in Germany; Carl Gegenbaur, the eminent comparative anatomist, and Julius Victor Carus, the zoologist and bibliographer, Correspondents of the Academy.

On the other hand, the luster of our rolls has been increased by the addition of the names of Theodor Boveri, William Morton Wheeler, Nestor Grehant, Eduard Strasburger and Hugo de Vries, who have been awarded the Academy's diploma in recognition of their distinguished services in the field of scientific research.

A marked increase in the interest manifested by its Correspondents in the affairs of the Academy has been evident. Twenty-six photographs and twenty-three biographical sketches of living Correspondents were received during the year, but a number have still failed to contribute to this record. Copies of the Annual Reports were sent to 243 Correspondents, some of whom, in returning acknowledgments, took occasion to congratulate the Academy on its work.

Letters of felicitation were forwarded to the Roumanian Geographical Society upon the receipt of a medal commemorating the twenty-fifth anniversary of its founding, and to the Silesian Society for National Culture upon the completion of the first century of its existence. To the Entomological Society of Belgium a letter of sympathy was sent upon the announcement of the death of its President, Pierre-Jules Tosquinet. Other correspondence with foreign societies was chiefly of a routine nature.

Following is a summary of the correspondence for the fiscal year:

Communications Received.

Acknowledging the Academy's publications,	198
Transmitting publications,	48
Requesting exchanges and the supply of deficiencies,	5
Invitations to participate in meetings, etc.,	3
Circulars concerning the administration of scientific institutions, research funds, etc.,	7
Notice of death of scientific man,	1
Photographs of Correspondents,	26
Letters from Correspondents,	32
Miscellaneous letters,	47
Total received,	367

Communications Forwarded.

Acknowledgments of gifts to the Library,	743
Acknowledgments of gifts to the Museum,	113
Acknowledgments of photographs,	26
Requests for the supply of deficiencies,	69
Copies of Annual Reports,	243
Correspondents' diplomas and notices of election,	11
Letters of congratulation and sympathy,	3
Letters to Correspondents,	115
Miscellaneous letters,	67
Total forwarded,	1,390

Respectfully submitted,

J. Percy Moore,

Corresponding Secretary.

REPORT OF THE LIBRARIAN.

The growth of the Library during the past year is represented by 6,737 additions. This is an increase of 651 over the accessions of last year, and is believed to be more than the receipts of any other year except when entire private libraries have been added by gift or bequest. Of these additions 5,512 were pamphlets and parts of periodicals, 1,017 were volumes and 208 were maps and sheets.

They were derived from the following sources:

Societies	2,490
I. V. Williamson Fund	1,285
General Appropriation	874
Editors	828
United States Department of the Interior	279
Authors	277
Meigs Fund	130
Wilson Fund	97
United States Department of Agriculture	89
University of Chicago	74
East Indian Government	36
Geological Survey of Sweden	22
George de Schweinitz, M.D.	19
Department of Agriculture, Cape of Good Hope	17
Comité Géologique Russe	17
State of Pennsylvania	16
Library of Congress	15
United States Department of State	13
Department of Mines, Victoria	13
Minister of Public Works, France	12
Henry C. Chapman, M.D.	12
Mexican Government	8
Conchological Section of the Academy	7
Geological Survey of India	6
Samuel G. Dixon, M.D.	6
Wisconsin Geological Survey	5
Geological Survey of New Jersey	5
Maryland Geological Survey	5
Philip P. Calvert, Ph.D.	5
United States War Department	4
Bureau of American Ethnology	4
Trustees of the British Museum	4
Geological Survey of Canada	4
Geological Survey of Georgia	4
Monsieur le Duc de Loubat	4
Philippine Exposition Board	4
Department of Mines, New South Wales	3
Joseph MacFarland, M.D.	3
Department of Mines, Nova Scotia	3
Comission Internacional de Limites entre Mexico y los Estados Unidos	3
United States Commission of Fish and Fisheries	2
United States Coast and Geodetic Survey	2
Department of Marine and Fisheries, Canada	2
William J. Fox	2
Ministry of Works, Peru	2
Commission des Travaux Géologique, Portugal	2
Queensland Government	2
Imperial Geological Survey, Japan	2
Bernice Pauahi Bishop Museum	2
Messrs. Schaeffer & Koradi	1
William E. Meehan	1
John Crerar Library	1
William L. Abbott, M.D.	1
Massachusetts Commissioners of Inland Fisheries	1
Library Association of Australia	1
Rev. H. C. McCook, D.D.	1
Geological Survey of Alabama	1

Geological Survey of Minnesota	1	Stewardson Brown	1
Philadelphia Commercial Museums	1	Department of Geology and Natural History, Indiana	1
Geological Survey of Michigan	1	Thomas Biddle, M.D	1
Trustees of the Indian Museum	1	Joseph Willcox	1
Geological Survey of Iowa	1		

They have been classified, catalogued and arranged in the Library under the following heads:

Journals	5,057	Mammalogy	43
Geology	469	Bibliography	42
Botany	246	Conchology	41
General Natural History	161	Ichthyology	39
Agriculture	93	Helminthology	34
Entomology	73	Physical Sciences	24
Anatomy and Physiology	69	Encyclopedias, etc	17
Anthropology	66	Chemistry	16
Voyages and Travels	56	Herpetology	11
Ornithology	49	Mathematics	10
Geography	45	Medicine	8
Mineralogy	44	Unclassified	24

The collection of lantern-slides, which is becoming year by year of more importance as illustrations for the courses of lectures delivered under the auspices of the Academy, has been increased by the addition of 262 views, the entire collection now numbering 1,243. A new cabinet to hold 1,000 slides has been provided and a card catalogue has been prepared by Dr. Benjamin Sharp. The additions of the year have been derived from the following sources: Charles Schaeffer, M.D., 25; Benjamin Sharp, M.D., 19; Henry Skinner, M.D., 7; purchased, 211.

A large collection of maps which had accumulated since the founding of the Academy and which was practically inaccessible, have been cleaned, trimmed and backed with linen; 2,128 pieces, forming upward of 9,000 square feet, have thus been treated. A case of drawers has been provided for them and they have been roughly classified and placed therein, to be more carefully arranged as soon as time can be found for the work.

An important part of the journals and periodicals reported has been received in answer to applications for deficiencies written in the course of preparing sets for the binding. Among the more interesting of such acquisitions is a complete set of the *Memoirs* of the Royal Academy of the Lincei of Rome, efforts to secure which had been made intermittently since 1883.

Sixty-one volumes of Government publications and 45 maps, either duplicates or not pertaining to the Academy's work, have been returned to the Government Printing Office. It is proposed to dispose in like manner of a large accumulation of State reports, etc., received from Harrisburg.

Seventeen hundred and forty-two volumes have been bound and an additional 157 volumes are now in the hands of the binder. Much the greater part of this work has been devoted to journals and transactions, thus securing a notable improvement in the appearance of this portion of the Library, and adding greatly to the convenience of those consulting it.

Notwithstanding the curtailment in the number of meetings the weekly accessions have been recorded, catalogued and placed for inspection by those interested in them every week as usual. The entries in the card catalogue have been prepared, including the titles of the smallest pamphlets, before the additions are placed in the Library. The entire catalogue is being carefully revised by the Assistant Librarian, to whom I am indebted, as usual, for efficient help during the year.

EDWARD J. NOLAN,
Librarian.

REPORT OF THE CURATORS.

The Curators report that the Museum and collections are in excellent condition, with many additions and advances in the arrangement as well as in the identification of the specimens.

The most conspicuous improvement during the year has been the opening of the new Ornithological gallery, in which more than half the collection of mounted birds—some 6,000 specimens—has been arranged and labelled. The remainder of the collection will be prepared for exhibition and transferred to its new quarters as fast as cases can be procured.

Plate-glass and mahogany cases, providing 4,343 cubic feet of exhibition space, have been erected during the year for birds, mammals, invertebrates and fossils, while Mr. Clarence B. Moore has presented one case for the valuable additions to his archæological collection. A number of storage and herbarium cases have also been provided for the accommodation of various study collections, making in all the greatest advance in the refurnishing of the Museum that has been effected in any one year.

The section of the basement of the new building in which the alcoholic collections are arranged has been materially enlarged to relieve its overcrowded condition. The alcoholic mammals have been entirely rearranged.

Improvements have been made to the steam-heating plant by the addition of radiators in the old building, and the elevator in the new museum has been altered to meet requirements of the municipal laws. An additional watchman has been employed.

Messrs. Henry W. Fowler and James A. G. Rehn have been added during the year to the staff of Museum assistants. Mr. Fowler has made important progress in the rearrangement of the general collection of fishes, but has devoted most of his time to identifying the large Sumatran collection recently received from Mr. Alfred C. Harrison, Jr., and Dr. H. M. Hiller. Mr. Rehn, besides assisting in various departments, has arranged and catalogued the Rhoads collection of mammals, bringing the entire series of the smaller mammalian skins into excellent order.

Details of the year's work will be found in the appended reports of the sections.

Dr. Moore has continued his work on the helminthological collection during the year, and Miss Wardle has made considerable advance in the cataloguing and arranging of the archæological material.

During the spring Dr. H. A. Pilsbry made a trip through portions of Arkansas, Indian Territory and Texas in the interests of the Academy and secured valuable series of mollusks, reptiles and plants, many of which were new to the collection.

Mr. Clarence B. Moore has continued to add to his unique and comprehensive collection of Indian antiquities from Florida and Georgia. His expedition of last winter proved to be unusually successful and the results make his department one of the most important in the Museum.

Most notable among the many additions to the zoological department was the magnificent collection of mounted anthropoid apes and skeletons presented to the Academy by Dr. Thomas Biddle.

A valuable series of fishes, which fills many gaps in our collection, was presented by the U. S. Fish Commission.

Dr. Henry C. Chapman has added a large number of specimens to the collection of marine invertebrates previously presented by him, and Mr. Joseph Willcox has contributed a notable series of fossil mollusks from Florida.

An extensive series of fossils from the Oligocene marls of Bowden,

not wholly unimportant has been accomplished toward the promotion of science.

The following officers have been elected for the year 1904:

Director, ...	Benjamin Smith Lyman.
Vice-Director, ...	George Vaux, Jr.
Recorder and Secretary, . . .	Miss Mary S. Holmes.
Treasurer, ...	Miss Emma Walter.
Conservator, ...	Frank J. Keeley.

Benjamin Smith Lyman,
Vice-Director.

The Biological and Microscopical Section.

Nine regular and several informal meetings have been held during the year, showing increased interest among the members, who now number thirty-five. The Conservator reports that the instruments of the Section are in their usual good working order and have been in regular use during the year.

The following additions have been made:

Eighty-nine slides, principally rock and mineral sections, received from the Curators of the Academy.

Two slides of quartz with inclusions, presented by Mr. Hugo Bilgram.

One Zentmayer Army Hospital Microscope and outfit, purchased.

Two small Queen Microscopes with objectives, purchased.

One Demonstration Microscope, purchased.

One Acme, No. 3, Microscope stand, formerly the property of Mr. Woolman, purchased.

Among the verbal communications and papers the following may be mentioned: New Species of *Trachelomonas*, by Mr. T. C. Palmer; *Myxomycetes* and liquid inclusions in quartz, by Mr. Hugo Bilgram; stained diatoms and models of microscopes and accessories, by Mr. F. J. Keeley; butter making and various pathological subjects, by Dr. J. C. Morris; remarks on specimens obtained in his travels, by Mr. S. L. Shumo; photographs of diatoms, by Dr. T. S. Stewart; slides of diatoms, by Mr. W. B. Davis, Mr. John A. Shulze and Mr. C. S. Boyer.

The Section has lost by death Dr. Charles Shaffer, a learned and valued member, and Mr. Lewis Woolman, who by his genial activity had become the personal friend of every active member of the Academy.

The officers elected for the following year are as follows:

Director,	J. Cheston Morris, M.D.
Vice-Director,	T. Chalkley Palmer.
Conservator,	F. J. Keeley.
Recorder,	C. S. Boyer.
Corresponding Secretary,	S. L. Schumo.
Treasurer,	Thomas S. Stewart, M.D.

CHARLES S. BOYER,
Recorder.

CONCHOLOGICAL SECTION.

The Conservator respectfully reports that the increase of the collection during the year has been very satisfactory, as shown by the list of accessions to the Museum. The general condition of the cabinet is practically unchanged from last year, and no substantial improvements in the arrangement of material can be made until more cases are supplied. As it does not seem desirable to enlarge our exhibition series of shells, it is recommended that a number of cases in the form of stacks, and about as high as the cases in the library, be built to contain series which it is not advisable to exhibit, either from the small size of the shells, the external uniformity of large numbers of species, or other reasons. These stacks may be placed in an enclosed space on the upper gallery or, better, on the lower floor of the Museum.

In March and April of this year the Conservator made a conchological reconnaissance of portions of the Ozark uplift in western Arkansas and Indian Territory, and of western Texas. The collection made comprises about 660 lots of mollusks, 163 reptiles of 34 species, 300 sheets of plants, and small collections of fossils, fishes, etc. It is believed that this collection adds materially to our knowledge of the mollusks of the Southwest. The study of this material is not yet completed.

Other collections worked upon during the year have been received from Mr. Hirase, including a large number of new species and affording a great mass of valuable zoogeographic data. A collection obtained by Mr. Clarence B. Moore in western Florida, reported on by Mr. Vanatta, adds considerable to our knowledge of the molluscan fauna of the north shore of the Gulf of Mexico. Many smaller accessions have also been determined and reported upon.

The Conservator has completed systematic studies on the families

Urocoptidæ and *Megaspiridæ*, the results being published in the *Manual of Conchology*, of which 322 pages and 62 plates have been issued during this year.

Throughout the year Mr. Vanatta has rendered invaluable assistance in the work of the department.

Respectfully submitted,

H. A. PILSBRY,

Conservator.

THE ENTOMOLOGICAL SECTION.

The Section has received many valuable additions to its cabinets during the year about to close, the largest being the collection of lepidoptera presented by the heirs of Mr. Charles A. Blake. This is contained in 70 book-boxes and numbers about 6,000 specimens. Important collections of orthoptera have been purchased, to the number of 1,360. They came from New Mexico, Arizona, Costa Rica, Argentina, Japan and Mexico. Mr. Morgan Hebard has presented an interesting and valuable collection of orthoptera from Michigan, numbering over a thousand specimens. Prof. T. D. A. Cockerell has donated 596 hymenoptera from New Mexico, and Mr. Henry L. Viereck has added 1,879 insects from various parts of the United States. The total number of specimens received by purchase or donation was 16,597. Some of these were types of new species and genera and a considerable number were new to the collection. Nine new genera and 56 new species were described by members of the Section during the year. The greater portion of the material received has been relaxed, mounted, furnished with data labels and incorporated in the various collections. One hundred and twelve Schmitt boxes have been purchased and four tin moth and dust-proof cases to hold them. Ten meetings of the Section have been held with an average attendance of fourteen persons. Thirty verbal communications have been made at the meetings, and the proceedings of the meetings have been published in *Entomological News*. One member died and two associates have been elected. *Entomological News* and *Proceedings* of the Entomological Section has been completed to the end of volume fourteen, with 340 pages and 15 plates. The collections and library have been used to a greater extent than ever, both by students here and from other institutions.

At the annual meeting held December 17, the following were elected to serve as officers for 1904:

Director,	Philip Laurent.
Vice-Director,	H. W. Wenzel.
Treasurer,	Ezra T. Cresson.
Recorder and Conservator,	Henry Skinner.
Secretary,	Frank Haimbach.

HENRY SKINNER,
Recorder.

THE BOTANICAL SECTION.

The Botanical Section reports that its meetings have been held regularly during the year, with a fair attendance of members.

A number of interesting and valuable communications have been made, many of which have been repeated before the general meetings of the Academy.

The Conservator reports that during the year considerable progress has been made on the work of arranging the collections. Special effort being directed to put in order the unmounted material which has accumulated in recent years, resulting in the poisoning of about 15,000 sheets, which have been mounted, numbered, catalogued and distributed in their proper places through the Herbarium.

Early in the summer new cases were erected in the center of the north room on the library floor. They are so arranged that their tops form two tables, each eighteen feet long by three feet broad.

This has added twenty-eight closets of twelve compartments each to the Herbarium space, which has resulted in relieving the overcrowded condition of a considerable portion of the collection.

During the year all of the Authophytes have been rearranged to conform to the family sequence of Engler and Prantl, commencing in the new cases above referred to, sufficient space being left to allow for additions to the families arranged in this room for some time to come.

The cases in the south room are, however, still much crowded, and will require additional cases for their relief.

Dr. Krout began, during the summer, the arrangement of the Mosses and Hepatics in the Academy's Herbarium. Thus far about 1,500 specimens having been put into pockets and mounted on sheets; these have been placed in cases in the south gallery room.

It is hoped to complete the arrangement of this portion of the collection during the coming year, so that it may be rendered available for study.

The additions to the Herbarium during the year have amounted to over 3,000 specimens; of these the Botanical Section has purchased from the income of the Redfield Fund 951—693 of these from Mr. A. A. Heller, collected by him in California during the past year, and containing a number of valuable additions in cotypes and specimens from original type localities. The remaining 258 specimens were purchased from Mr. Charles L. Pollard, collected by himself and Messrs. William and Dr. Edward Palmer, in the Province of Santiago, Cuba, during the early part of 1902; this collection also adds much of interest to the Herbarium in the way of new material.

The Academy has purchased 280 specimens of Mexican plants, collected by Mr. C. G. Pringle for 1901 and 1902.

The Academy's expedition to Arkansas, Indian Territory and western Texas early in the year, under Dr. Pilsbry, brought back about 300 sheets of plants, which will form an interesting collection from this region. The balance of the additions have been received as donations from sundry individuals, the most noteworthy being collections from Washington and Idaho, presented by Mr. C. V. Piper; from California and New Mexico, presented by Mr. C. F. Saunders; from the northwestern United States and British Columbia, presented by Dr. James Darrach, and a collection of Mosses from various parts of the United States, presented by Mrs. Anne Morrill Smith, with others, a detailed list of which will be found in the additions to the Museum.

The Conservator wishes to acknowledge assistance received in the arranging of the collections from Miss Ada Allen, assistant in the Herbarium, and Mr. Raymond Winter, a Jessup Fund beneficiary.

The Philadelphia Botanical Club has continued to hold its meetings in the Academy, its members having added about 300 specimens to the local Herbarium during the year.

At the meeting of the Section held Monday December 14, the following were elected as its officers to serve for the ensuing year:

Director, ...	Benjamin H. Smith.
Vice-Director, ...	Joseph Crawford.
Recorder, ...	Dr. Ida A. Keller.
Treasurer and Conservator, . . .	Stewardson Brown.

STEWARDSON BROWN,

Conservator.

THE ORNITHOLOGICAL SECTION.

During the past year the Conservator has completed the arrangement of the mounted collection of water birds and Gallinaceæ in the new Ornithological gallery, four additional cases having been provided for their accommodation. Three other cases now about finished will permit of the transference of the Ostriches and Birds of Prey early in the coming year. The gallery was opened to the public on November 12, and has attracted much attention, as the specimens are displayed to far better advantage than formerly. Beside the labelling of the individual specimens, large explanatory cards have been prepared for the various families, giving their geographic distribution, number of species and some of the most striking characteristics.

The further systematic arrangement of the study collection of skins has been facilitated by the provision of five tin cases and two large wooden cases, so that the entire series is now preserved in modern moth-proof cases, except the Anatidæ, Tyrannidæ, Cuculidæ and Birds of Prey.

The overcrowded condition of several of the cases has also been relieved.

A fine series of California skins numbering about 700 specimens was purchased by the Academy early in the year. The collection illustrates many of the plumages of our Western birds not hitherto represented, and contains quite a number of geographic races new to the cabinet.

In return for aid in identifying the collection of birds in the Philadelphia Commercial Museums, the Conservator obtained a fine series of specimens from South America and Africa, of which the Academy was much in need.

Another valuable collection was presented by Mr. Adolf van der Wielen, and a fine collection of eggs of North Dakota birds was received from Dr. William E. Hughes.

The Delaware Valley Ornithological Club has added several specimens of the now nearly complete collection of local birds and nests presented some years ago.

All the material received during the year has been catalogued and labelled, making an addition of about 1,100 specimens.

The Delaware Valley Ornithological Club and the Pennsylvania Audubon Society have held their meetings in the building during the year, and on November 16–19 the American Ornithologists' Union

held their Annual Congress at the Academy, the meeting proving the largest in the history of the organization.

Much aid has been given during the year to ornithologists of other institutions, both by loan and by placing our material at the disposal of visiting students.

In the work of the department the Conservator is much indebted to Mr. J. A. G. Rehn for valuable assistance.

The officers elected for the ensuing year are:

Director,	Spencer Trotter, M.D.
Vice-Director,	George Spencer Morris.
Secretary,	William A. Shryock.
Recorder,	Stewardson Brown.
Treasurer and Conservator,	Witmer Stone.

Respectfully submitted,

WITMER STONE,
Conservator.

The election of Officers, Councillors and Members of the Committee on Accounts to serve during 1904 was held with the following result:

PRESIDENT,	Samuel G. Dixon, M.D.
VICE-PRESIDENTS,	Arthur Erwin Brown,
	E. G. Conklin, Ph.D.
RECORDING SECRETARY,	Edward J. Nolan, M.D.
CORRESPONDING SECRETARY,	J. Percy Moore, Ph.D.
TREASURER,	George Vaux, Jr.
LIBRARIAN,	Edward J. Nolan, M.D.
CURATORS,	Henry C. Chapman, M.D.
	Arthur Erwin Brown,
	Samuel G. Dixon, M.D.
	Henry A. Pilsbry, D.Sc.
COUNCILLORS TO SERVE THREE YEARS,	——— ———[1]
	C. Newlin Peirce,
	Philip P. Calvert, Ph.D.
	Thomas Biddle, M.D.
COMMITTEE ON ACCOUNTS,	Charles Morris,
	Harold Wingate,
	Samuel N. Rhoads,
	Philip P. Calvert, Ph.D.
	——— ———[1]

[1] Vacancies unfilled out of respect to the memory of Dr. Charles Schaeffer, who was nominated for these offices.

COUNCIL FOR 1904.

Ex-officio.—Samuel G. Dixon, M.D., Edwin G. Conklin, Ph.D., Arthur Erwin Brown, Edward J. Nolan, M.D., J. Percy Moore, Ph.D., George Vaux, Jr., Henry A. Pilsbry, D.Sc., and Henry C. Chapman, M.D.

To serve Three Years.—Dr. C. Newlin Peirce, Philip P. Calvert, Ph.D., Thomas Biddle, M.D.

To serve Two Years.—Thomas A. Robinson, Charles Cramp, Charles Morris and Isaac J. Wistar.

To serve One Year.—Thomas Fenton, M.D., Edwin S. Dixon, John Cadwalader and William Sellers.

Curator of Mollusca, ...	Henry A. Pilsbry, D.Sc.
Assistant Librarian, ...	William J. Fox.
Assistants to the Curators, . .	Witmer Stone,
	Henry Skinner, M.D.,
	Stewardson Brown,
	J. Percy Moore, Ph.D.,
	Edward G. Vanatta,
	Henry W. Fowler,
	J. A. G. Rehn.
Taxidermist, ...	David McCadden.
Jessup Fund Students, ...	J. A. G. Rehn,
	Harriet Newell Wardle.
Janitors, ...	Charles Clappier,
	Daniel Heckler,
	James Tague,
	Jacob Aebley.

ELECTIONS DURING 1903.

MEMBERS.

January 27.—James Spear, Jr., Edward B. Meigs, Henry A. Lang.

February 24.—Lucy H. Baird.

March 31.—Charles Z. Tryon.

April 28.—John V. Shoemaker, M.D.

October 20.—Edward G. Vanatta, Thomas Barbour, Frederick L. Lewton, Allen J. Smith, M.D., Theodore Brooks.

November 17.—Morgan Hebard, Henry W. Fowler.

CORRESPONDENTS.

January 27.—William Morton Wheeler, of Austin, Texas; Theodore Bovari, of Würzburg.

November 17.—Nestor Gréhant, of Paris; Eduard Strasburger, of Bonn; Hugo de Vries, of Amsterdam.

ADDITIONS TO THE MUSEUM.

ARCHÆOLOGY AND ETHNOLOGY.

COL. GEORGE S. ANDERSON. Implements for collecting sap, Luzon, Philippines.

B. F. DONALDSON. Arrow points and flint implements, San Marcos, Texas.

CLARENCE B. MOORE. Many Indian antiquities from Florida, additions to the Clarence B. Moore Collection. Casts of the skulls and bones from Spy.

LT. HUGH L. WILLOUGHBY. Seminole canoe from the Florida Everglades.

MAMMALS.

THOMAS BIDDLE, M.D. Mounted specimens and skeletons of the Gorilla (*Anthropopithecus gorilla*), Chimpanzee (*A. niger*), Bald Chimpanzee (*A. calvus*), Chimpanzee (*A. calvus*?), Orang Utan (*Simia satyrus*); also skeletons of a young Orang Utan (*S. satyrus*) and Man.

STEWARDSON BROWN. One Brown Bat, *Eptesicus fuscus*.

P. P. CALVERT, Ph.D. Brown Bat, *Eptesicus fuscus*.

C. N. B. CAMAC, M.D. Skeleton of well-formed Negro, deposited in the Museum by the late Dr. Camac.

H. C. CHAPMAN, M.D. Brain of Chimpanzee and Orang Utan and articulated cranium of young Lion, placenta of *Dasypus sexcinctus*.

W. E. CRAM. Marmot skin (*Arctomys*), New Hampshire.

W. H. FLUCK. Ten Bats, Nicaragua.

GEOGRAPHICAL CLUB OF PHILADELPHIA. Whale skull, Nome, Alaska, collected by Prof. Angelo Heilprin.

H. C. KIRKPATRICK. Two skins, *Blarina brevicauda*.

DAVID MCCADDEN. Albino Muskrat skin (*Fiber zibethecus*), four Bear skulls, British Columbia.

H. A. PILSBRY, Sc.D. Two Bats, Texas and Arkansas.

PURCHASED. Three Buffaloes (*Bison bison*), 325 skins and skulls of California mammals, two Alaskan Sheep (*Ovis dalli*), skulls of *Melursus labiatus* and *Felis couguar hippolestes*, 50 skins and skulls from Tamaulipas, Mexico, 3 *Odocoileus*, Chihuahua.

SAMUEL N. RHOADS. Several small mammals from Delaware, skins and alcoholic.

S. L. SCHUMO. Five immature Opossums, Coban, Nicaragua.

W. WERNRICH, JR. Human fœtus and fœtus of Pig.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. Specimens prepared as indicated: Mounted: Binturong, *Arctictis binturong;* two Coquerel's Dwarf Lemurs, *Microcebus coquereli*. To be mounted: Tenrec, *Centetes ecaudatus;* two Javan Cats, *Felis javanensis;* Grison, *Grison vittata;* Dasyure, *Dasyurus viverrinus*. Skins and skulls: two Kangaroo Rats, *Dipodomys spectabilis;* two *Peromyscus truei*?; Wood Rat, *Neotoma micropus canescens;* Raccoon, *Procyon hernandezi;*

two Indian Civets, *Vivericula malaccensis;* Azara's Fox, *Canis azaræ;* Corsac Fox, *Vulpes corsac;* Black-footed Ferret, *Putorius nigripes;* Red Howling Monkey, *Alouatta senicula;* Sooty Mangaby, *Cercocebus fuliginosus;* two Doguera Baboons, *Papio doguera.* Skin and Skeleton: Tenrec, *Centetes ecaudatus;* Sloth, *Bradypus sp.* Skulls: Prong-horned Antelope, *Antilocapra americana;* Himalayan Bear, *Ursus thibetanus;* Japanese Macaque, *Macacus fuscatus.* Alcoholic: *Nyctinomus mexicanus; Papio cynocephalus juv.; Tatu novemcinctum.*

Birds.

Lt.-Col. George S. Anderson. Three bird skins, Philippines.

Thomas Biddle, M.D. Mounted *Gallus sonerati.*

J. G. Dillen. Skin of Hawk Owl, Parry Sound.

J. D. Gordon. Barn Owl, *Strix pratincola.*

B. T. Gibbs, Jr. Two Reed Birds, *Dolichonyx oryzivorus* (skins).

William E. Hughes, M.D. Collection of eggs, North Dakota.

H. W. Hand. Short-eared Owl, *Asio accipitrinus.*

Delaware Valley Ornithological Club. Mounted specimen Least Bittern, *Ardetta exilis;* Two Turkey Vultures, *Cathartes aura;* Little Blue Heron, *Ardea cærulea.*

J. P. Norris, Jr. Nest, eggs and skin of *Dendroica auduboni nigrifrons.*

Charles B. Penrose, M.D. Hybrid Duck, *Anas boschas* × *Nettion carolinensis* (skin).

Samuel N. Rhoads. Ten bird skins, Delaware.

Mrs. Charles Schaeffer. Red-tailed Hawk, *Buteo borealis* (skin).

James Spear, Jr. Skins of White Ibis and Florida Cormorant.

William D. Winsor. Two skins of Great Blue Heron, *Ardea herodias.*

Adolf van der Wielen. A collection of skins from Pennsylvania, California and Maine.

Purchased. Four mounted Flamingos, *Phænicopterus ruber;* seven hundred Californian bird skins.

Philadelphia Commercial Museums. Collection of bird skins from South America and Africa, received in return for identifications.

Zoological Society of Philadelphia. Specimens prepared as follows: Skins: Gray Struthidea, *Struthidea cinerea;* Red-shafted Flicker, *Colaptes cafer;* two Meadow Larks, *Sturnella magna hoopesi;* Crested Hangnest, *Ostinops decumanus;* two Parrots, *Callocephalon galeatum; Lorius garrulus; Coturnix pectoralis; Myadestes unicolor; Passer luteus;* Bare-throated Francolin, *Pternistes leucoscepus; Chrysotis vinacea; Palæornis longicauda; Aprosmictus erythropterus;* two Hanging Parakeets, *Loriculus stigmatus;* Sordid Parrot, *Pionus sordidus.* Skull and sternum: Mexican Black Hawk, Hawk-headed Parrot. Several birds' nests from Pecos, Texas.

Reptiles and Batrachians.

Miss Fanny Batten. Two specimens of *Phrynosoma cornutum,* Texas.

C. R. Biederman. *Eublepharis variegatus,* Arizona.

Charles Clappier. Several specimens of *Plethodon erythronotus.*

Miss L. Fell. Two *Phrynosoma cornutum.*

W. H. FLUCK. Collection of reptiles from Nicaragua.

JOHN A. LEARY. Several *Typhlomolge rathbuni*, San Marcos, Texas.

MISS JOSEPHINE MCMENAMIN. Young Alligator.

EDW. A. MCILHENNY. A series of three-toed Box Tortoises, *Terrapene triunguis*.

H. A. PILSBRY. A collection of reptiles and batrachians from Missouri, Arkansas, Indian Territory and Texas.

J. A. G. REHN. *Ophibolus rhombomaculatus*, Maryland, and *Agkistrodon contortrix*, Lehigh county, Pennsylvania.

S. N. RHOADS. Two batrachians and several reptiles from Delaware.

C. T. SANDS. A collection of Ophidia from Fairfax county, Virginia, and four specimens from Mt. Pocono, Pennsylvania.

WITMER STONE. *Storeria occipitomaculata*, New Jersey; several Salamanders, Delaware.

S. L. SCHUMO. *Diadophis punctatus*, Philadelphia.

H. L. VIERECK. Thirteen reptiles and batrachians, southern New Jersey.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. Rattlesnake, *Crotalus* sp.; *Testudo calcarata*, Abyssinia; *Sternothrenis nigricans; Tumpinambis teguexin.*

FISHES.

H. C. CHAPMAN, M.D. Seven species of fish.

EXCHANGE. With Stanford University, a large series of Japanese fishes.

G. J. ENT. *Chætodipterus faber*, Anglesea, New Jersey.

W. H. FLUCK. A series of fishes from Nicaragua.

H. W. FOWLER. Six Porgies, a Mullet and specimen of *Pomolobus;* collection of small fishes from Trenton, New Jersey.

A. GULICK. Two Lanceolets, Bermuda.

H. WALKER HAND. Two *Squalus acanthus*, Cape May, New Jersey.

J. P. MOORE. Three *Gymnosarda alliterata*, Woods Hole, Mass.

J. L. NICHOLSON. Specimen of *Lopholatilus chamæleonticeps*. Gulf Stream.

H. A. PILSBRY, Sc.D. Small collection of fish from Texas.

PURCHASED. Small series of Mexican fishes.

S. N. RHOADS. *Achirus fasciatus* and *Eupomotis gibbosus*, Sussex county, Delaware; also dried head of *Lepisosteus osseus*.

BENJAMIN SHARP, M.D. Twenty-two species of fish from Nantucket, Massachusetts.

JAMES SPEAR, JR. A collection of fishes from the coast of Florida.

U. S. FISH COMMISSION. Collection of fishes from Hawaiian Islands.

H. L. VIERECK. *Mugil curema* and *Ammodytes americanus*, Cape May, New Jersey.

H. T. WOLF. A small collection of fishes from Dingman's Ferry, Pennsylvania.

MOLLUSKS.

JOHN A. ALLEN. Eleven species of American shells.

C. F. ANCEY. Ten species of land and fresh-water shells.

PAUL BARTSCH. *Sonorella walcottiana* Bartsch from California.

CHARLES BAUM, M.D. *Polygyra albolabris* Say from Morristown, New Jersey.

C. R. Biederman. Two species of land shells from Reef, Arizona.

A. C. Billups. *Polygyra barbigera* Redf. from South Carolina.

A. C. Boyer and J. A. Shulze. Five species of fresh-water shells from South America.

F. H. Brown. Four species of land and marine shells from New Jersey and Pennsylvania.

L. B. Brown. Thirty-three species of land and fresh-water shells from Barbados.

Stewardson Brown. Four species of land shells from Lancaster county, Pennsylvania.

Owen Bryant. Seven species of shells from Bermuda.

Fred L. Button. Six species of American shells.

P. P. Calvert, Ph.D. Two species of marine shells from Nahant, Massachusetts.

A. J. Carson. *Mya arenaria* L. from San Francisco county, California.

H. C. Chapman, M.D. Twenty-nine species of mollusca in alcohol from Naples and Bar Harbor, Maine.

George H. Clapp. Types of *Punctum clappi* Pils. and two species of Ampullaria.

J. M. Clarke. *Helix hortensis* Müll. from Canada.

T. D. A. Cockerell. Thirty-one species of land shells from Mexico and New Mexico.

H. S. Colton. Sixty-five trays of land and marine shells from Maine and Pennsylvania.

Charles H. Conner. Nine species of Unionidæ from the Delaware river, New Jersey.

Miss Mary Cooper. Twenty-two species of land shells from New Mexico in exchange.

Prof. W. H. Dall. *Anodonta coarctata* Ant. from Mexico.

L. E. Daniels. Four trays of land shells from Indiana.

Edw. Dietrich. Five species of land and marine shells from Siquijor.

H. E. Dore. *Vitrea cellaria* Müll. from Portland, Oregon.

Prof. Arthur M. Edwards. Five species of land shells from Bermuda.

V. N. Edwards. Sixteen jars of New England Nudibranchs.

Sir Charles Eliot. Forty-three lots of shells from Zanzibar and East Africa.

Capt. F. Ericksen. Three species of marine shells from New Caledonia.

John Ford. *Cypræa caurica oblongata* Melv.

L. S. Frierson. Five specimens of Unionidæ from Alabama and Louisiana.

Mrs. M. S. Goodman. *Epiphragmophora fidelis* Gray from Portland, Oregon.

A. Gulick. One hundred and twenty-four species of land and marine shells from Bermuda and Japan.

S. H. Hamilton. *Polygyra albolabris* Say from Bucks county, Pennsylvania.

A. C. Harrison, Jr., and Dr. H. M. Hiller. Sixteen species of Sumatran shells.

Charles Hedley. Nine species of marine shells from New South Wales.

J. B. Henderson, Jr. *Archegocoptis crenata* from Haiti.

Henry Hemphill. Collection of land snails from the islands off California.

Dr. H. M. Hiller. Eight species of Cuban land shells.

Y. Hirase. Two hundred and seventy lots of Japanese land shells.

P. W. Jarvis. Seven species of Jamaican land shells.

HOWARD JONES. Eight Atlantic City marine shells.

W. H. JONES. Ten lots of marine shells from Peru.

DR. IDA A. KELLER. Two species of marine shells from Sea Isle City, New Jersey.

GEORGE F. KUNZ. Five species of land and fresh-water shells from Hartman's Cave, Pennsylvania.

EDWIN H. H. LEWIS. Twelve lots of American shells.

J. G. MALONE. Twenty-three species of marine and fresh-water shells from Bahia, Brazil, and Seattle, Washington.

ALBERT G. MAY. *Bythinia tentaculata* L. from Syracuse, New York.

R. C. MCGREGOR. Twenty-two lots of Hawaiian land and fresh-water shells.

E. A. MCILHENNY. Thirty-nine lots of Alaskan shells.

MILWAKUEE PUBLIC MUSEUM. One hundred and twenty lots of fresh-water shells.

CLARENCE B. MOORE. Twenty-one lots of marine shells from Florida.

O. A. NYLANDER. Three species of fresh-water shells from Maine.

PHILADELPHIA COMMERCIAL MUSEUMS. Ninety-nine lots of shells.

H. A. PILSBRY, Sc.D. Six hundred and sixty lots of land and fresh-water shells.

PURCHASED. Seventy-six lots of shells from S. N. Rhoads, and Sowerby and Fulton.

J. A. G. REHN. Three trays of land shells from Pennsylvania.

S. N. RHOADS. Ninety-four lots of land and fresh-water shells from eastern United States and Mexico.

J. RITCHIE, JR. One *Plectotropis* from Assam.

W. H. RUSH, M.D. Thirty-nine lots of shells from the Philippine Islands.

H. E. SARGENT. Four lots of American land shells.

SILAS L. SCHUMO. One hundred and thirty-one lots of marine shells from the West Indies.

C. T. SIMPSON. Thirteen species of land and fresh-water shells from Haiti and Jamaica.

BENJAMIN H. SMITH. *Planorbis dilatatus* Gld. from McCall's Ferry, Pa.

BURNET SMITH. *Fulgur canaliculata* from Atlantic City, New Jersey.

V. C. SMITH. Two species of marine shells from Florida.

R. E. SNODGRASS. Thirteen lots of land and fresh-water shells from Washington.

JAMES SPEAR, JR. Fourteen lots of marine shells from Florida.

WITMER STONE. Two species of land shells from Essington, Pennsylvania.

H. STUPAKOFF. Four lots of land shells from Swissvale, Pennsylvania.

D. THAANUM. Twenty-three lots of marine shells from Hawaii, New Guinea and Queensland.

MAX UHLE. *Conus fergusoni* Sowb., from Peru.

H. L. VIERECK. Three species of fresh-water and marine shells from eastern United States.

BRYANT WALKER. Fifteen lots of American land and fresh-water shells.

PROF. H. WARD. Three lots of American fresh-water shells.

JOSEPH WILLCOX. Nine species of land and fresh-water shells from Kissimmee river, Florida.

H. T. WOLF. Two species of American *Neritina*.

B. B. WOODWARD. Four lots of European *Vitrea*.

L. WOOLMAN. Four trays of New Jersey marine shells.

PROF. A. A. WRIGHT. *Mactra plicataria* L.

INSECTS.

R. LEWIS BENDER. *Citheronia regalis*, New Jersey.

WILLIAM BEUTENMULLER. Sixteen Coleoptera, North Carolina

C. A. BLAKE (HEIRS OF). Six thousand Lepidoptera.

J. C. BRADLEY. Nine Orthoptera, Pennsylvania and New Jersey.

A. E. BROWN. Nests of *Polistes texanus*, Pecos, Texas.

D. M. CASTLE. Thirty-four Coleoptera, Florida; seventy Hemiptera, Florida: twenty-five miscellaneous, Florida.

T. D. A. COCKERELL. Five hundred and ninety-six Hymenoptera, New Mexico; twenty-one Orthoptera, *Alcyrodes vitrinellus* (type), Mexico.

J. C. CRAWFORD. Eight Hymenoptera, Costa Rica.

E. T. CRESSON. Thirty Hymenoptera, Utah.

E. DAECKE. One Moth.

A. FENYES. Three Coleoptera, southern California (exch.).

W. J. FOX. One Coleoptera, Pennsylvania.

W. H. FLUCK. Twenty-six vials of insects, Nicaragua.

G. FRANCK. Three Heterocera, Florida.

C. B. HARDENBURG. Eight Coleoptera, Mexico.

MORGAN HEBARD. Four Coleoptera, Georgia; one thousand and six Orthoptera, Michigan; ninety-two Orthoptera, Pennsylvania; one hundred and twenty-seven butterflies, Japan.

H. M. HILLER. Seventy-two insects from Cuba.

N. W. JANNEY. Seven hundred and ten Coleoptera, Pennsylvania.

W. D. KEARFOTT. Eight Lepidoptera, U. S.

PHILIP LAURENT. Four Heterocera, Florida.

L. W. MENGEL. Eleven Heterocera, Asia.

H. A. PILSBRY. One hundred insects, Indian Territory.

EDW. POTTS. Three insects, U. S.

F. L. REHN. One Orthoptera, one Hymenoptera, Delaware county, Pennsylvania.

J. A. G. REHN. One hundred and thirty-six Orthoptera, Ocean county, New Jersey; one hundred and nineteen Orthoptera, Tinicum, Delaware county, Pennsylvania; two Orthoptera, Maryland.

S. N. RHOADS. Fifteen Odonata, Mexico; forty Odonata, Delaware.

CHARLES ROBERTSON. Three Hymenoptera, Illinois.

C. T. SANDS. Two Coleoptera, Virginia.

F. G. SCHAUPP. Collection Orthoptera and Odonata from Texas, sixty-two specimens.

BURNETT SMITH. Three Ticks, Pennsylvania.

THOMAS SPALDING. Eight Myrmeleons, Utah.

WITMER STONE. Sixteen Orthoptera and Diptera, Pennsylvania.

U. S. NATIONAL MUSEUM. Sixty-three exotic Orthoptera (exch.).

E. C. VAN DYKE. Forty-eight Coleoptera, California.

H. L. VIERECK. One thousand five hundred and fifty-four Hymenoptera, one hundred Orthoptera, one hundred and seventy-five Lepidoptera, one hundred and

thirty-seven Neuroptera, seventy-five Coleoptera, eight hundred and thirty-eight miscellaneous, United States.

E. M. WALKER. Four Orthoptera, Canada.

H. W. WENZEL. One Coleoptera, New Jersey.

JOSEPH WILLCOX. Fifty insects, Florida.

H. F. WOLF. One specimen, Pennsylvania.

W. M. WHEELER. Small collection of Orthoptera.

The following were purchased:

J. C. BRADLEY. Two hundred and fifty Hymenoptera, Japan.

L. BRUNER. One hundred and ninety-five Orthoptera, Argentina.

Y. HIRASE. Three hundred and fifty-three Orthoptera, Japan.

J. F. MCCLENDON. Two hundred and ninety Orthoptera, Mexico.

C. F. UNDERWOOD. Eight hundred and forty-seven Hymenoptera, Costa Rica.

C. R. BIEDERMAN. Two thousand five hundred insects, Arizona.

WORMS.

JOHN ALLEN. *Bipalium Kewense.*

H. C. CHAPMAN, M.D. Six bottles of *Polychæta* and *Tearnica branchialis.*

J. PERCY MOORE, Ph.D. Eleven bottles of *Polychæta*, Woods Hole, Massachusetts, and two of *Tomopteris*, *Mermis*, Woodbury, New Jersey.

H. A. PILSBRY. Two earthworms, Arkansas and Missouri.

S. N. RHOADS. *Filaria* from *Dendroica cærulea* and earthworms from Mexico.

WITMER STONE. *Placobdella*, New Jersey.

U. S. FISH COMMISSION. One hundred and twenty-one bottles of *Polychæta* (cotypes), Japan.

E. G. VANATTA. *Eisenia fœtida*, Maryland.

JOSEPH WILLCOX. Four earthworms, Florida and Georgia. *Ascaris* and *Meroscolea.*

OTHER INVERTEBRATES.

CHARLES W. BUVINGER. Two Crabs, Atlantic City, New Jersey.

H. C. CHAPMAN, M.D. Forty-two jars of invertebrates from Naples.

E. A. DANIELS, M.D. *Crossaster papposus*, Dark Harbor, Maine.

EDW. DIETRICH. Two Sponges from Siquijor.

SIR CHARLES ELIOT. Four jars of Echinoderms and seven Crabs, Zanzibar.

CAPT. F. ERICKSEN. *Lysiosquilla maculata*, New Caledonia.

REV. W. H. FLUCK. Several invertebrates, Nicaragua.

MRS. T. C. HENRY. *Lepas* sp. from Spring Lake, New Jersey.

MRS. E. M. GAYLORD. *Waldheimia grayi.*

H. M. HILLER, M.D. Hermit Crab, Cuba.

H. A. PILSBRY, Sc.D. *Palæmon jamaicensis*, Del Rio, Texas.

J. G. MALONE. Two species of *Terebratella*, Mary Island, Alaska.

S. N. RHOADS. Several invertebrates from Monterey, Mexico.

JAMES SPEAR, JR. A collection of Crustacea, etc., Florida.

H. L. VIERECK. *Balanus eburneus*, from Seaside Park, New Jersey.

JOSEPH WILLCOX. Sponge and *Cambarus* from Florida.

Vertebrate Fossils.

Grand Lodge of Pennsylvania, F. and A. M. (Committee on Library). A collection of mammalian fossils and several Turtles from Nebraska.

Invertebrate Fossils.

Daniel Baugh. *Clypeaster ægypticus* and *Nummulites gizehensis*, Egypt.

Thomas L. Casey. Fourteen trays of fossils, Vicksburg, Mississippi.

Grand Lodge of Pennsylvania, F. and A. M. (Committee on Library). A number of specimens from Nebraska.

Henry Merrihew. Several specimens of fossils.

H. A. Pilsbry, Sc.D. Three *Exogyra arietina* and twelve other fossils from southwestern United States.

John Ross. Six Echinoderms and mollusks collected by Fraser Cristie.

Rev. C. H. B. Turner. Collection of fossiliferous pebbles, Lewes, Delaware.

H. A. Walters. Two fossils from British Columbia.

Joseph Willcox, *Arca idonea* from St. Mary's, Maryland, and a series of fossil mollusks from Florida.

Minerals, etc.

C. R. Biederman. Ten double-terminated quartz crystals and specimen of Alunite, New Mexico; Gold quartz, Copper river, Alaska.

Capt. F. Ericksen. Chrome ore with silver and nickel.

Joseph Finney. Chalcopyrite, Pyrrhotite and Cuprite, Holland, Pennsylvania.

Ariel Harrison. Fulgurite, Malaga, New Jersey.

E. S. Lemmon. Collection of minerals and rock specimens.

John Ross. Small collection of minerals.

S. L. Schumo. Bottle of volcanic dust from Mt. Pélee eruption.

Joseph Willcox. Selenite, St. Mary's, Florida.

Plants.

Stewardson Brown. Two hundred and fifty Pennsylvania and New Jersey plants.

Botanical Section. Three hundred and twenty-five species from Porto Rico, six hundred and ninety-three species from California, two hundred and fifty-eight from Cuba.

William M. Canby. Twenty-nine sheets of *Cratægus*.

Joseph Crawford. One hundred and fifty sheets of *Carices*.

James Darrach, M.D. Fifty sheets of plants from northwestern United States and British Columbia.

J. W. Eckfeldt, M.D. Fifty-seven species of Lichens.

J. H. Ferriss. Collection of Ferns and flowering plants, Texas.

J. W. Harshberger, Ph .D. Fifty-five plants, North Carolina mountains.

A. A. Jones, M.D. *Phyllanthus pallidifolius*.

A. F. K. Kraut. Twenty-seven species of Mosses.

Ida A. Keller, Ph.D. Two specimens of Azalea.

C. V. Piper. Collection of Washington plants, one hundred and ninety-eight species.

H. A. Pilsbry. Collection of plants from Indian Territory and Texas.

Edw. Potts. *Linaria vulgaris.*

Purchased. Two hundred and eighty plants from Mexico.

S. N. Rhoads. Fifty species from Mexico.

S. L. Schumo. Fruit of Mahogany, Antigua, and specimen of *Tillandsia recurvata*, St. Kitts, and two West Indian plants.

Mrs. A. M. Smith. One hundred and seven species of Mosses.

C. F. Saunders. One hundred and twenty plants, New Mexico and California.

Witmer Stone. One hundred Pennsylvania and New Jersey plants.

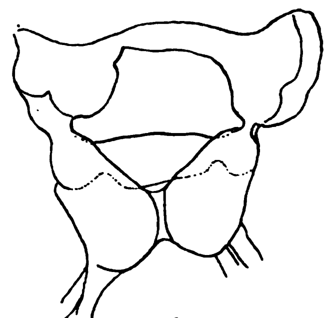
William Trimble, M.D. Hybrid Walnut, leaf and fruit.

C. S. Williamson. One hundred and thirty-one species of plants, Catskill Mountains.

U. S. National Museum. Ten species Violets.

INDEX TO SPECIES, ETC., DESCRIBED AND REFERRED TO IN THE PROCEEDINGS FOR 1903.

Species described as new are indicated by heavy-faced, synonyms by italic numerals.



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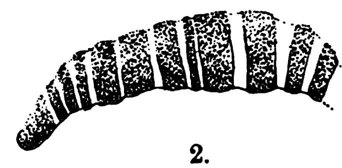

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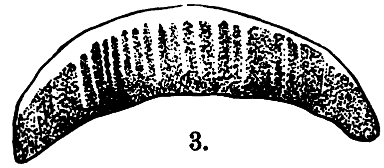

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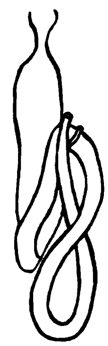

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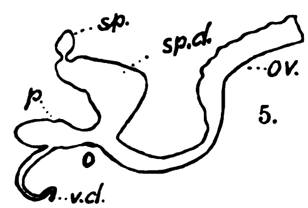

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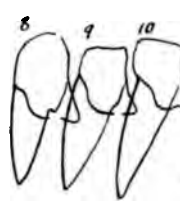

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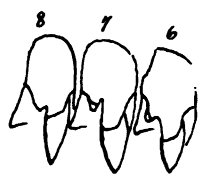

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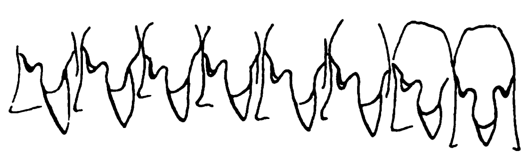

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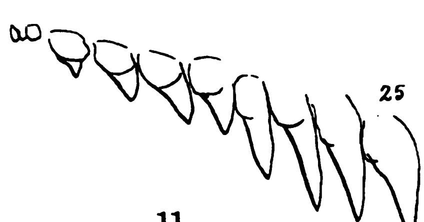

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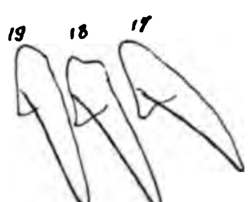
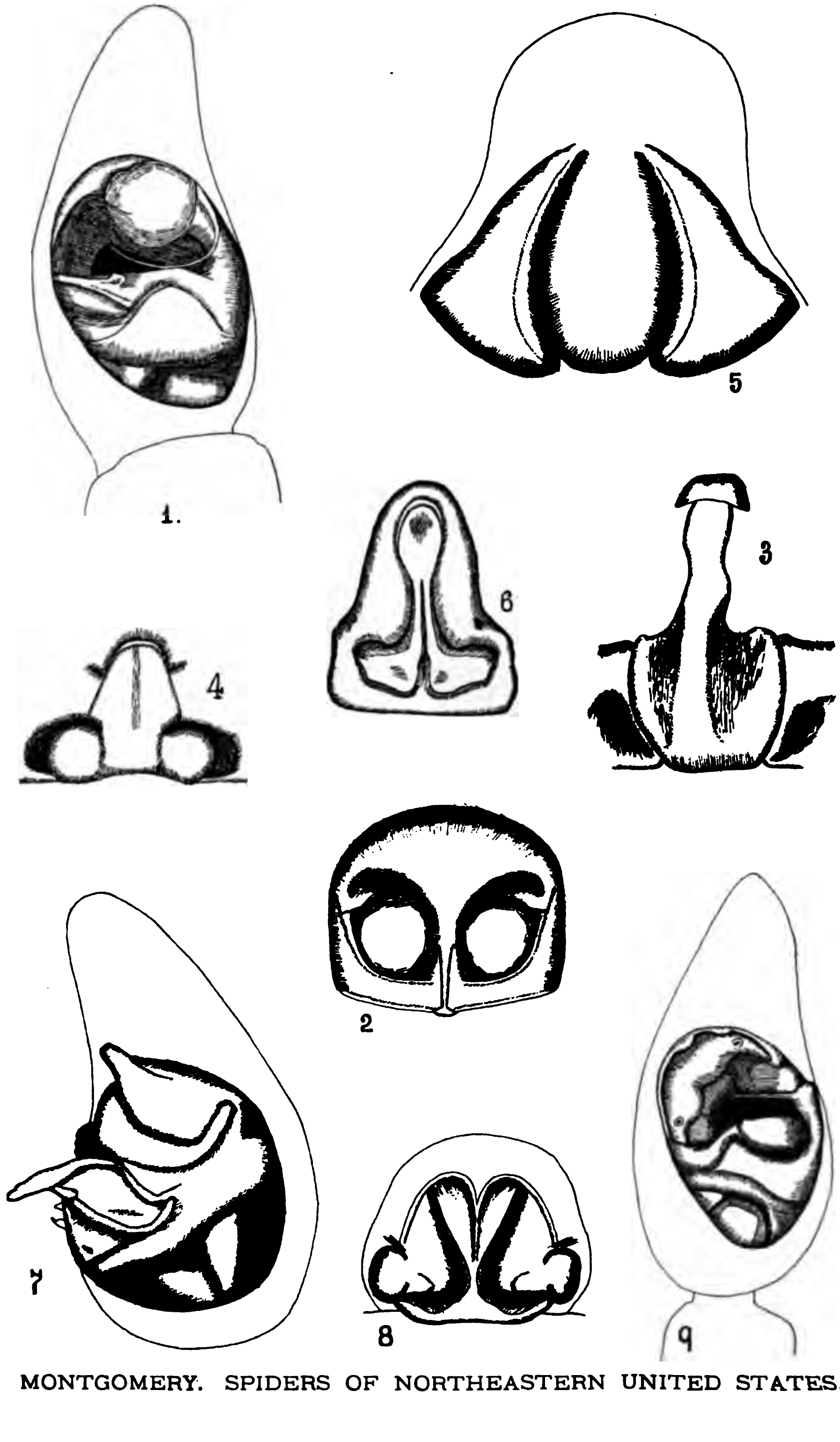
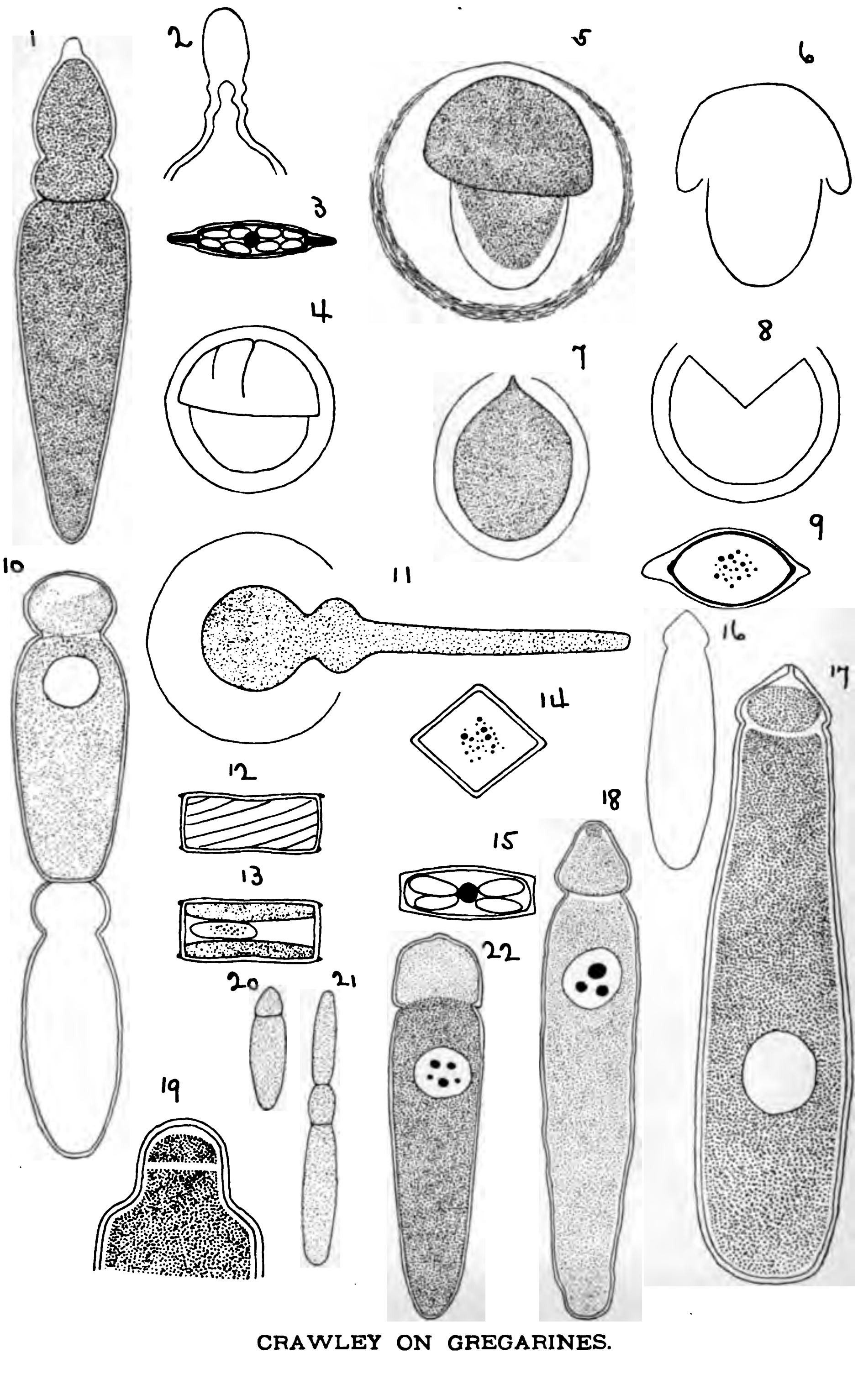


10.

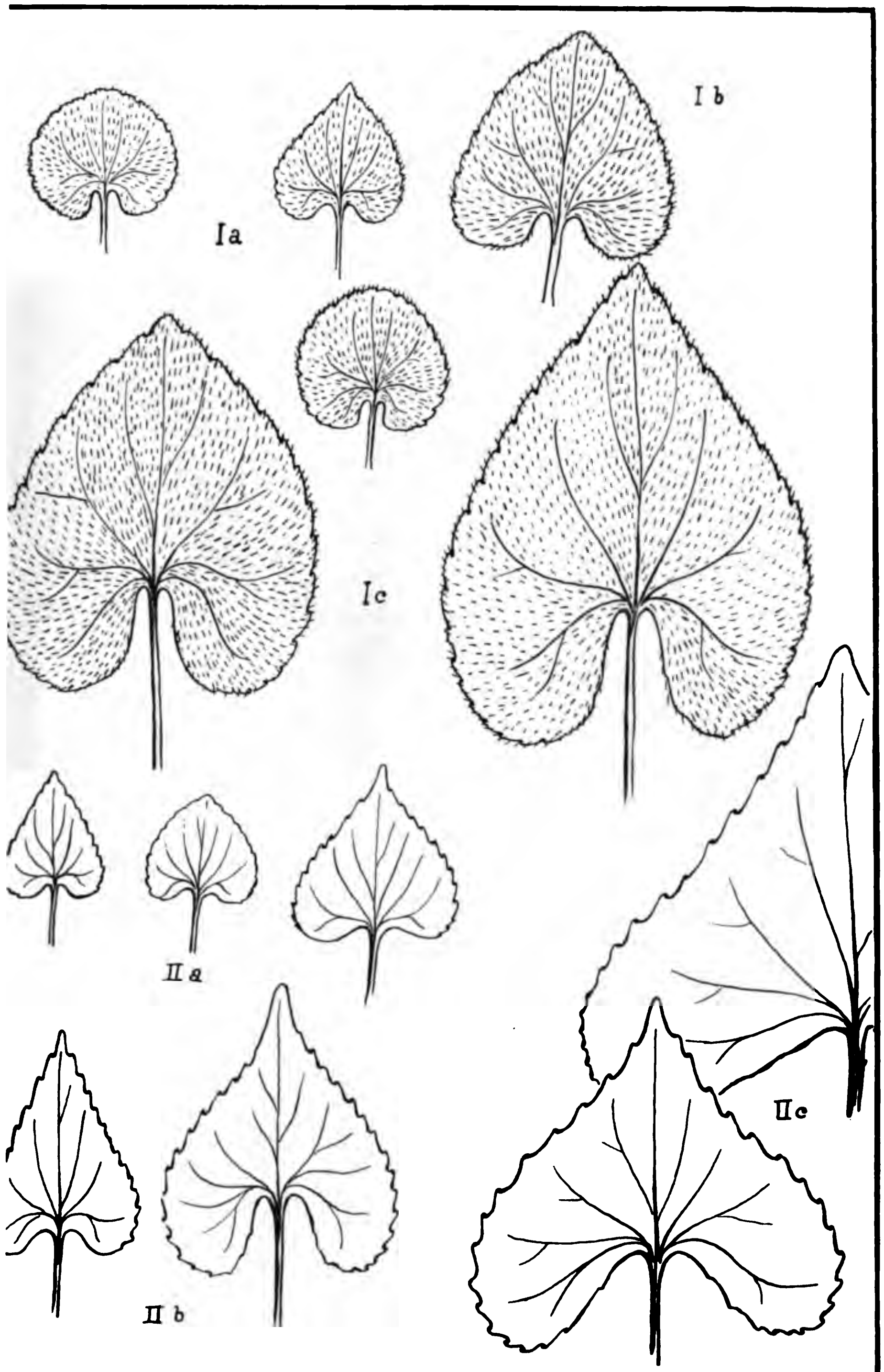
PILSBRY. A NEW AMERICAN ARIONID.



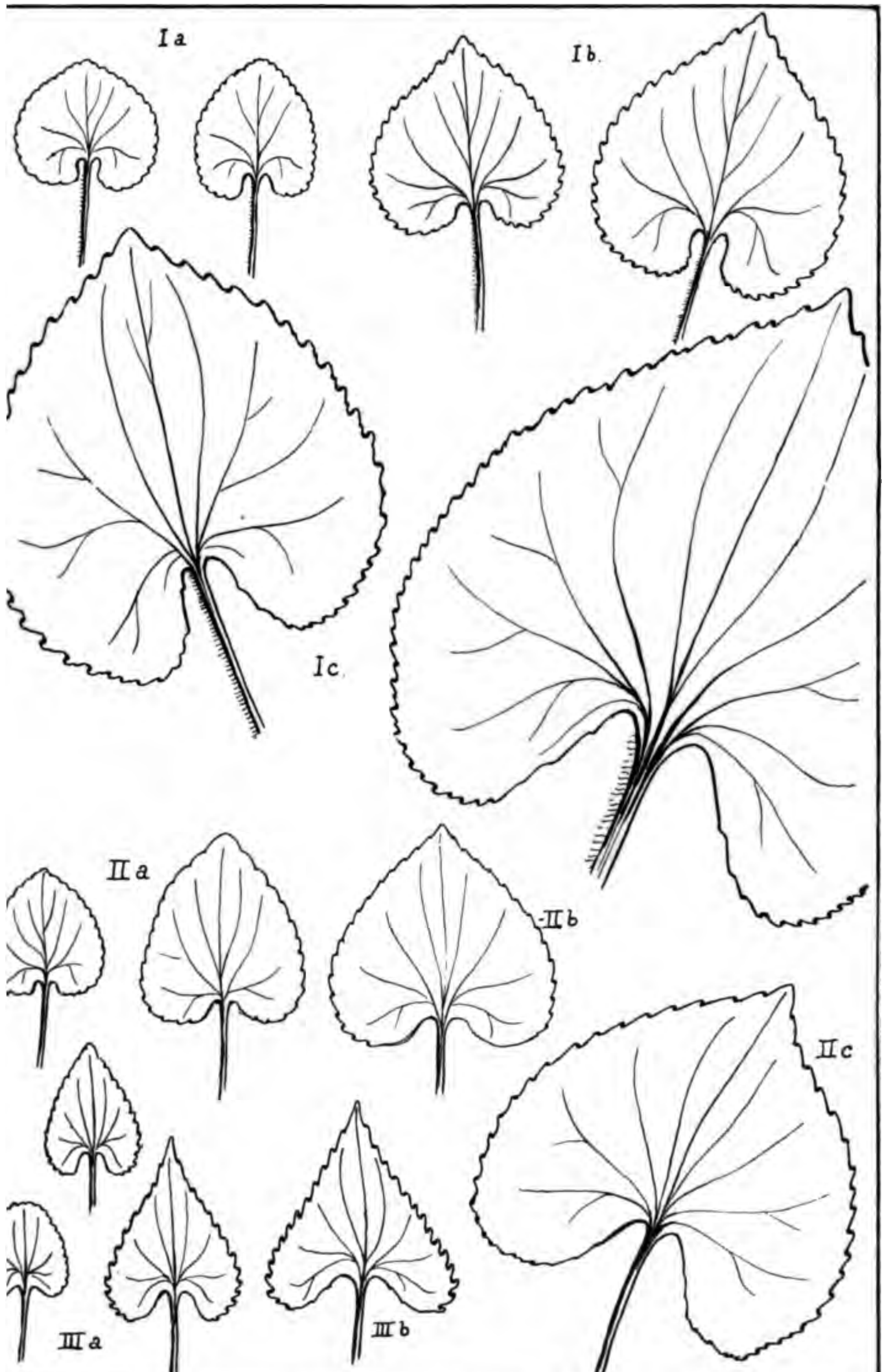
MONTGOMERY. SPIDERS OF NORTHEASTERN UNITED STATES.



CRAWLEY ON GREGARINES.



STONE. VARIATION IN VIOLETS.



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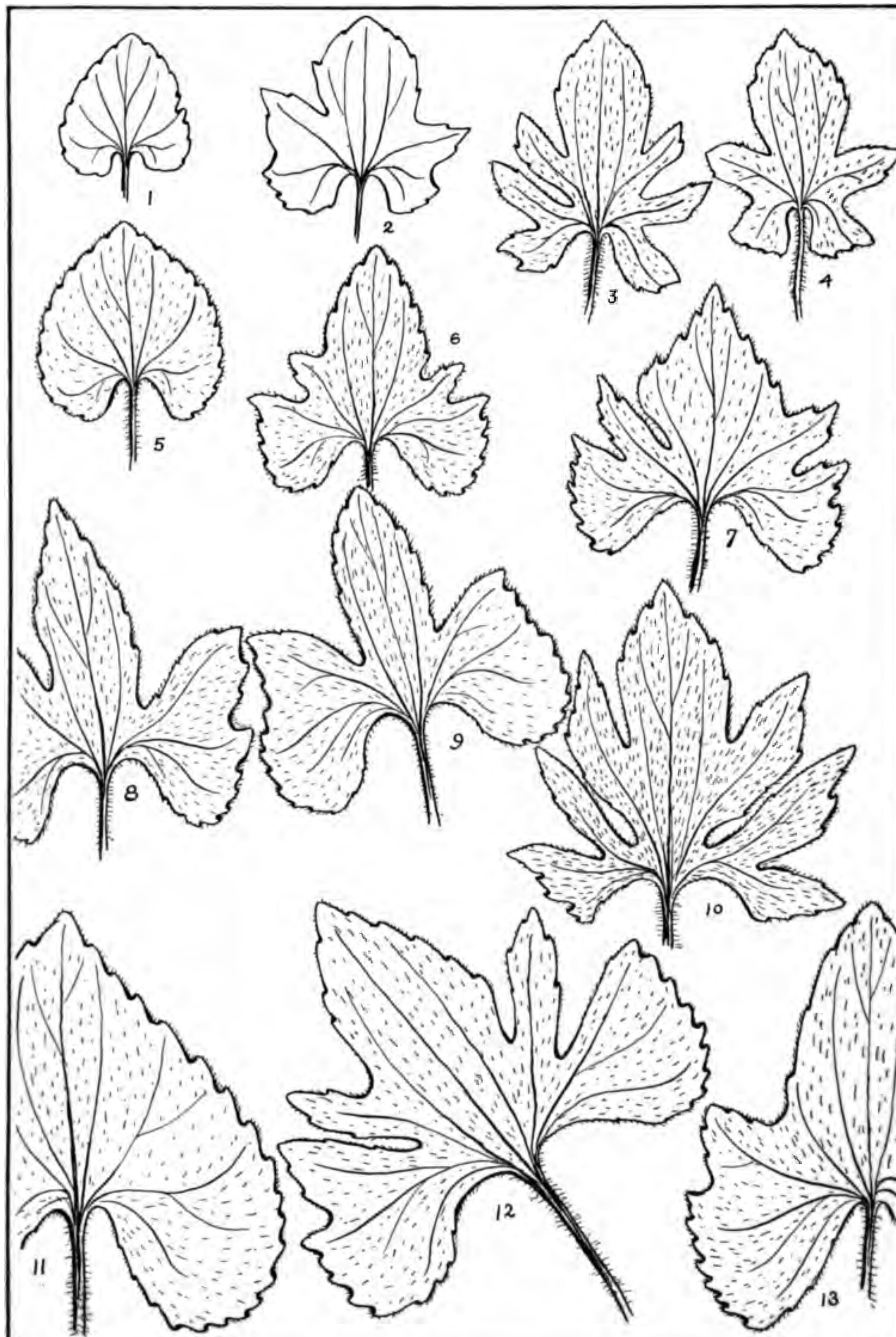

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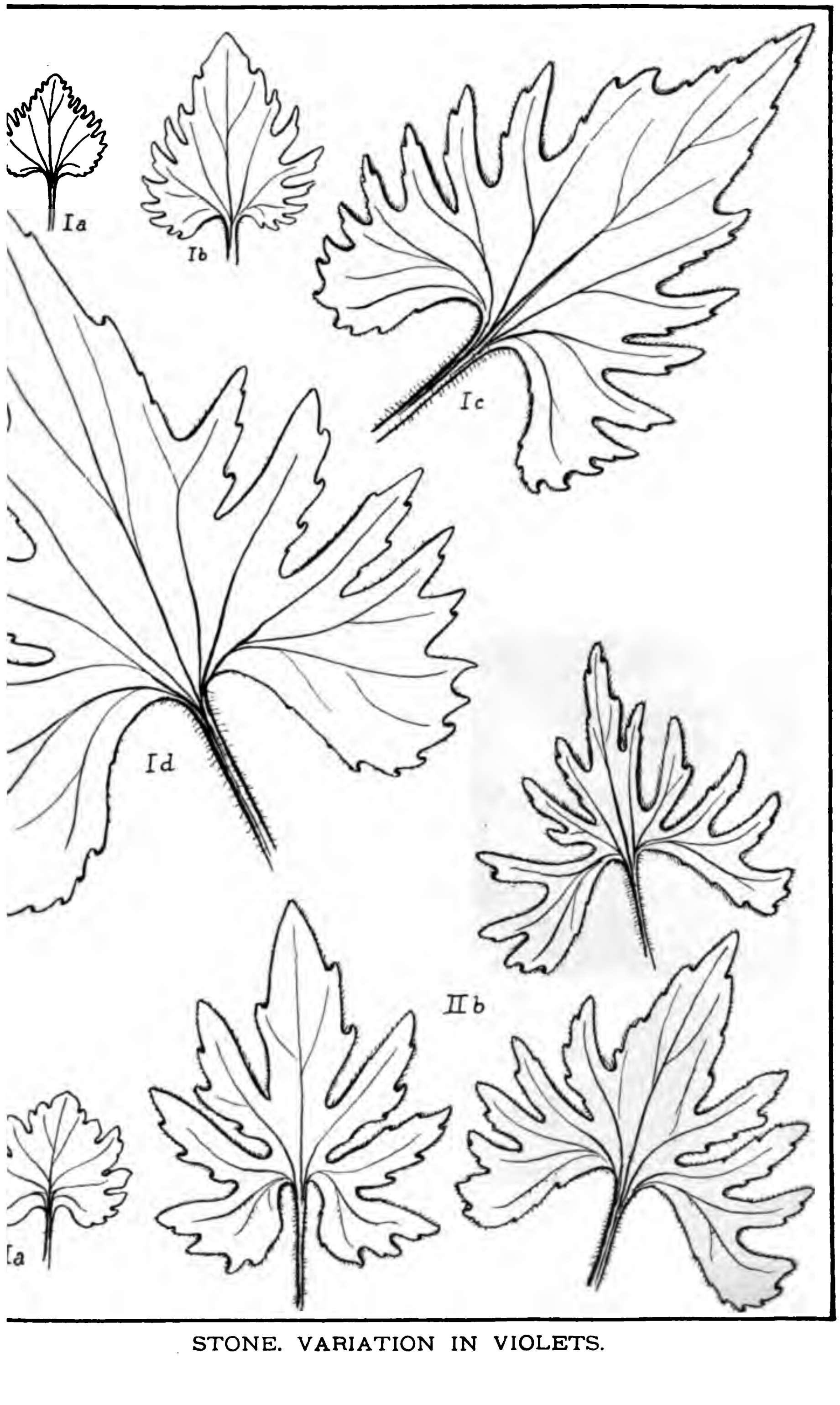

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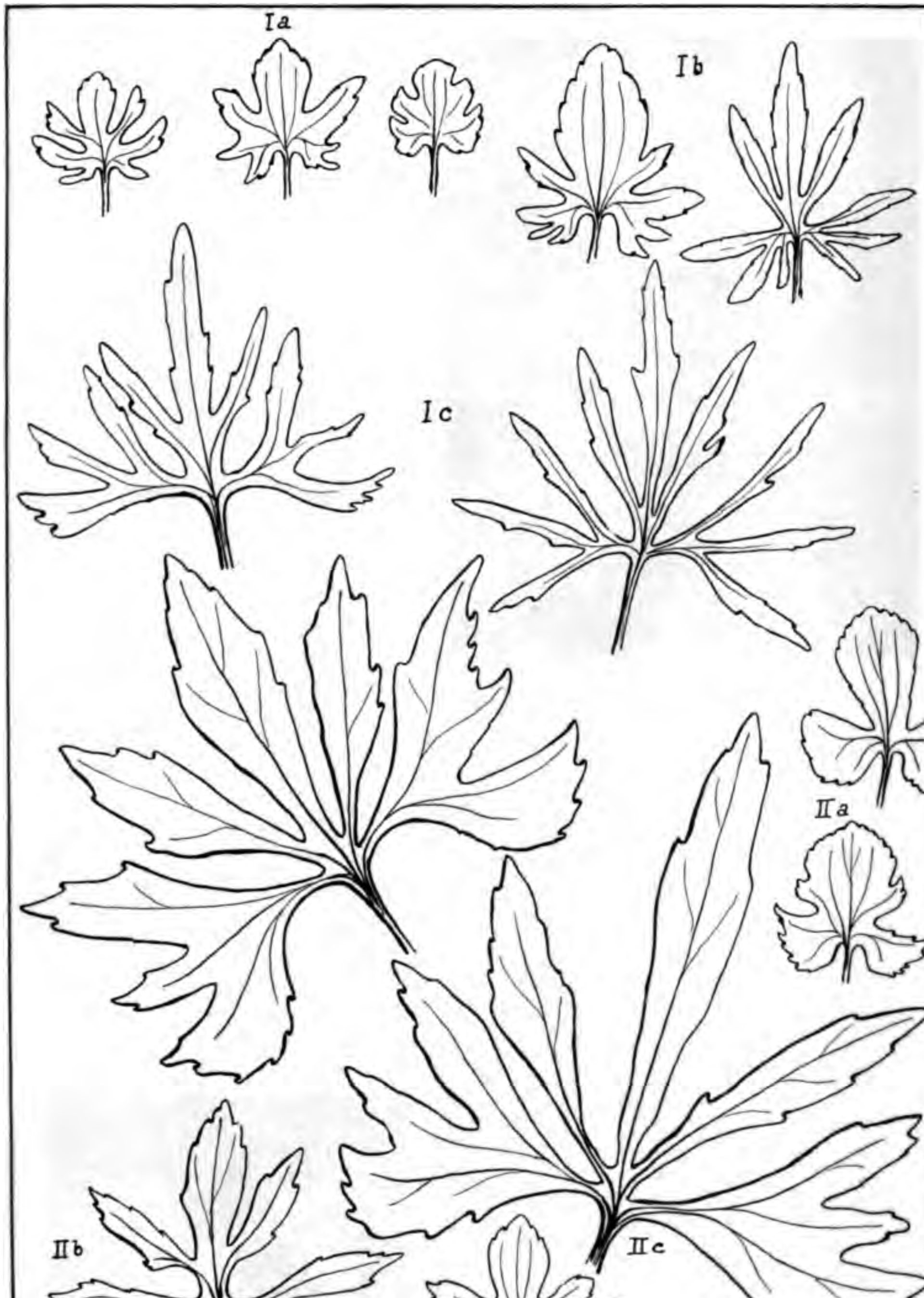

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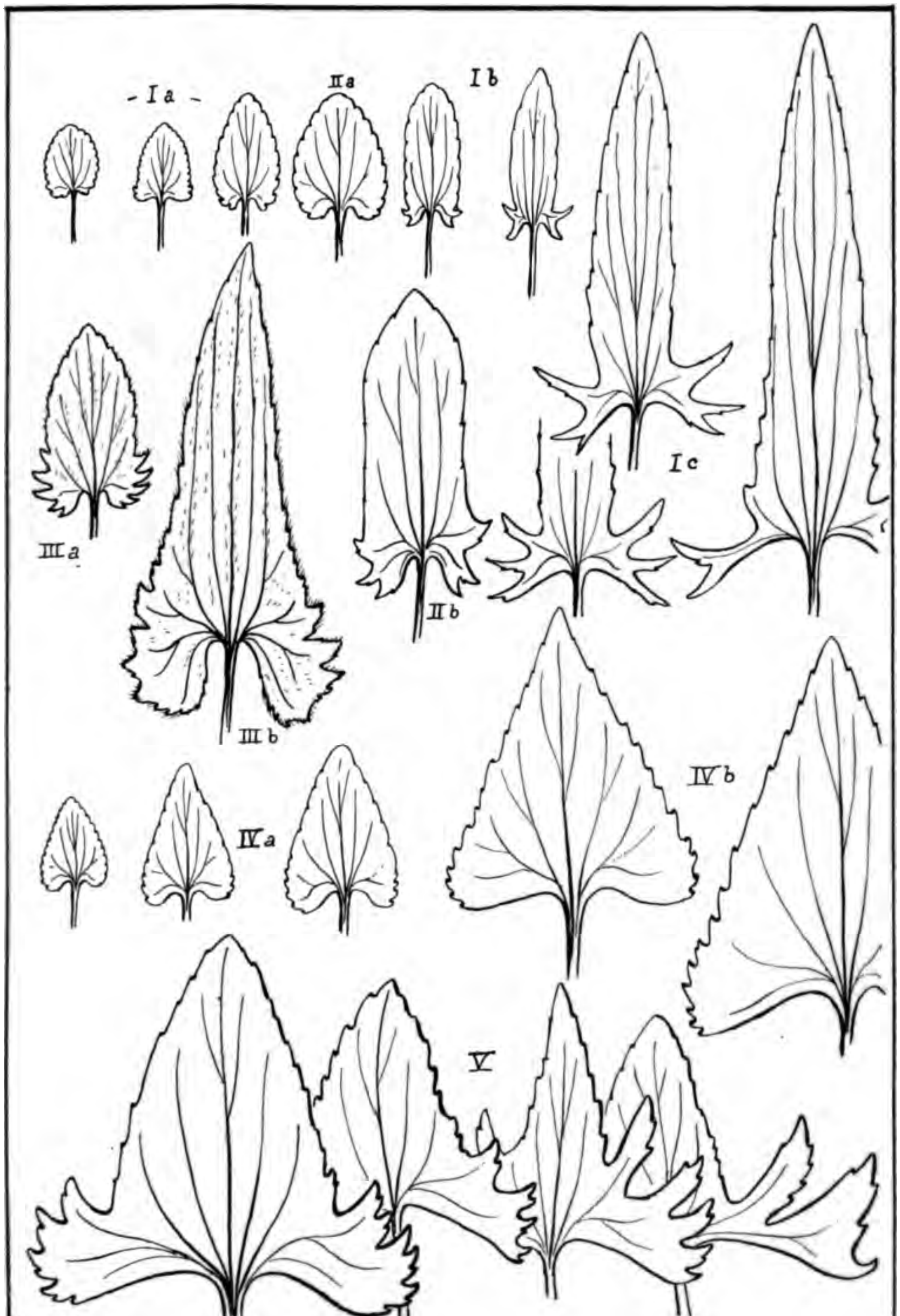

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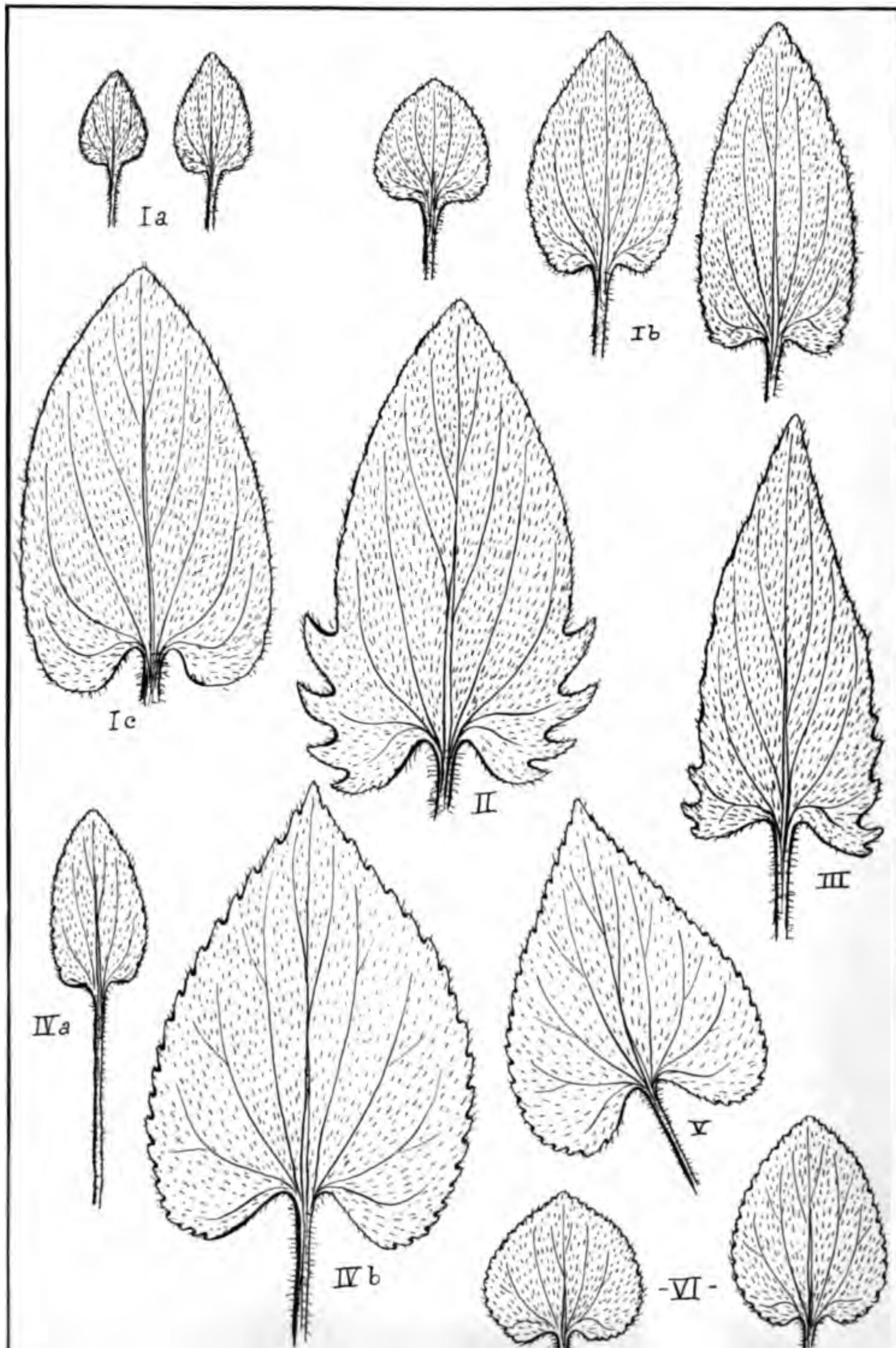

STONE. VARIATION IN VIOLETS.


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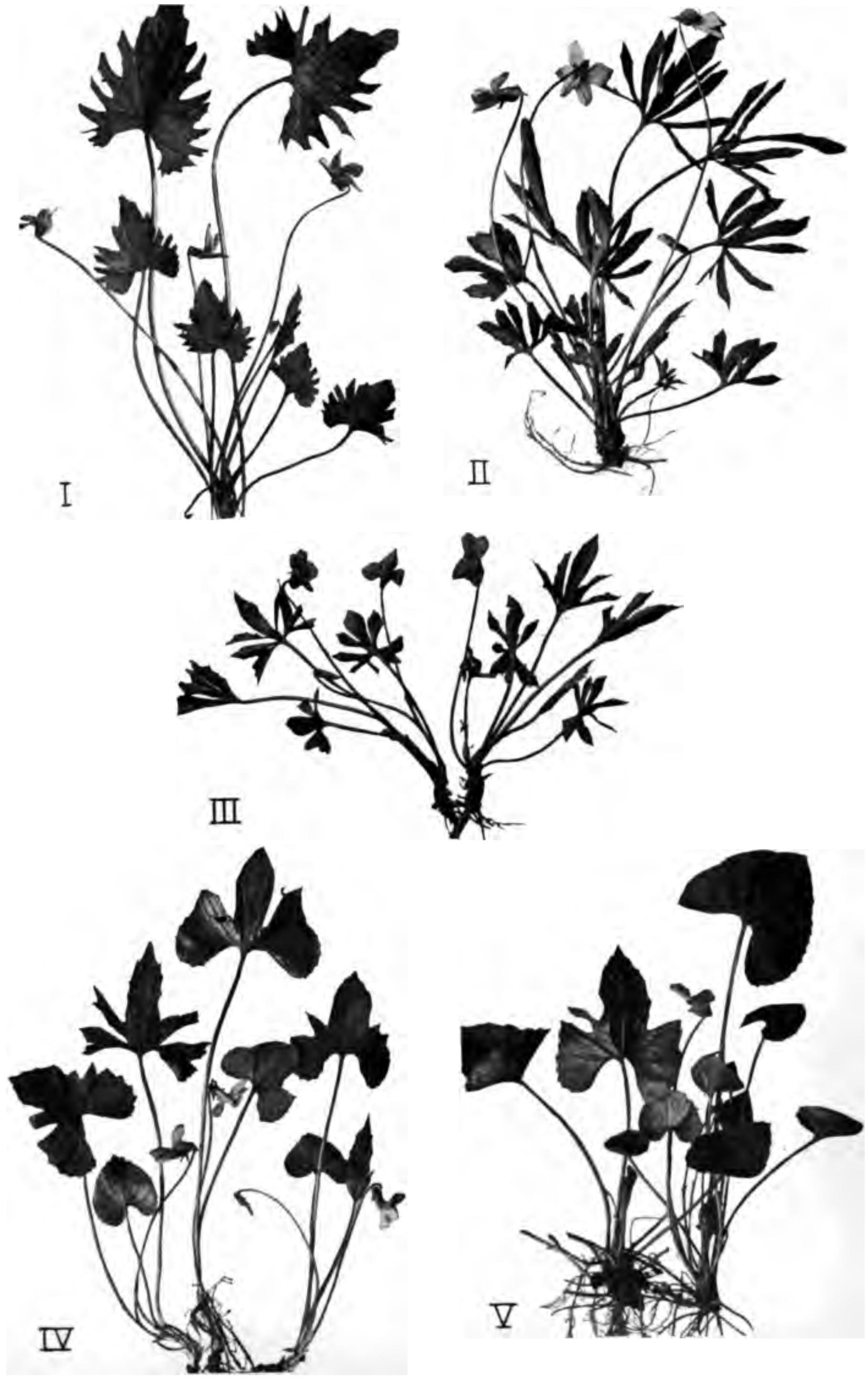
II
III
IV
V



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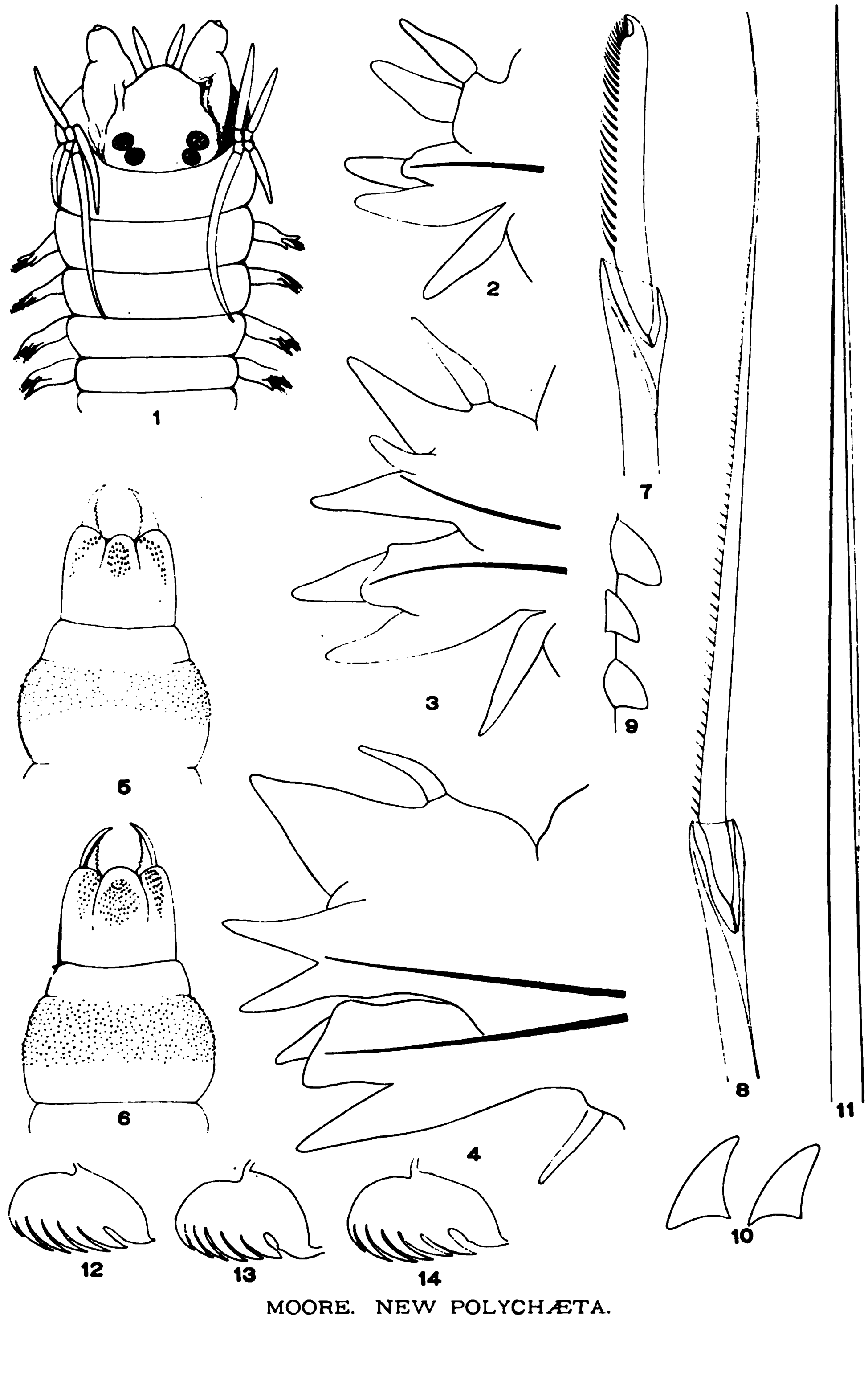
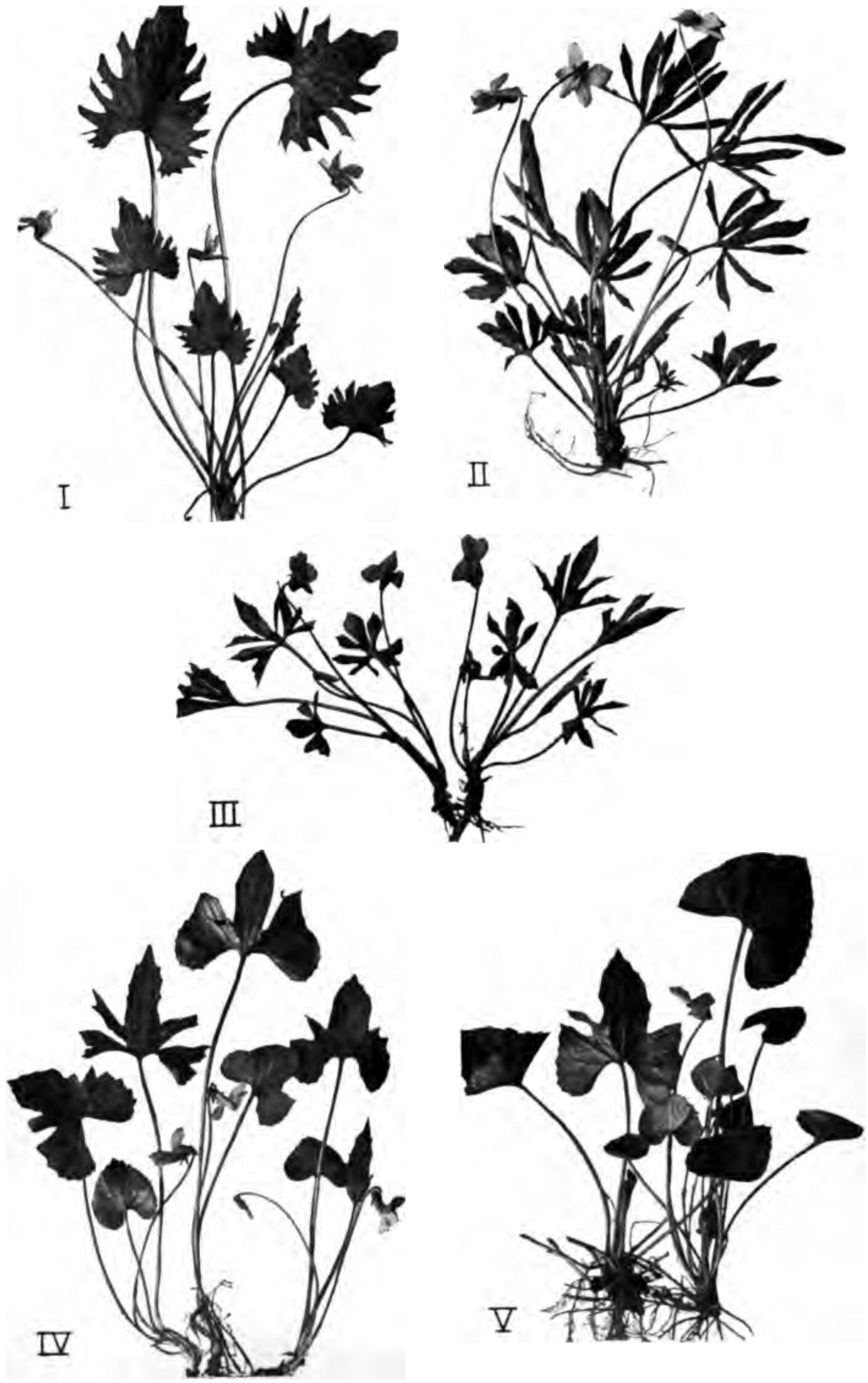
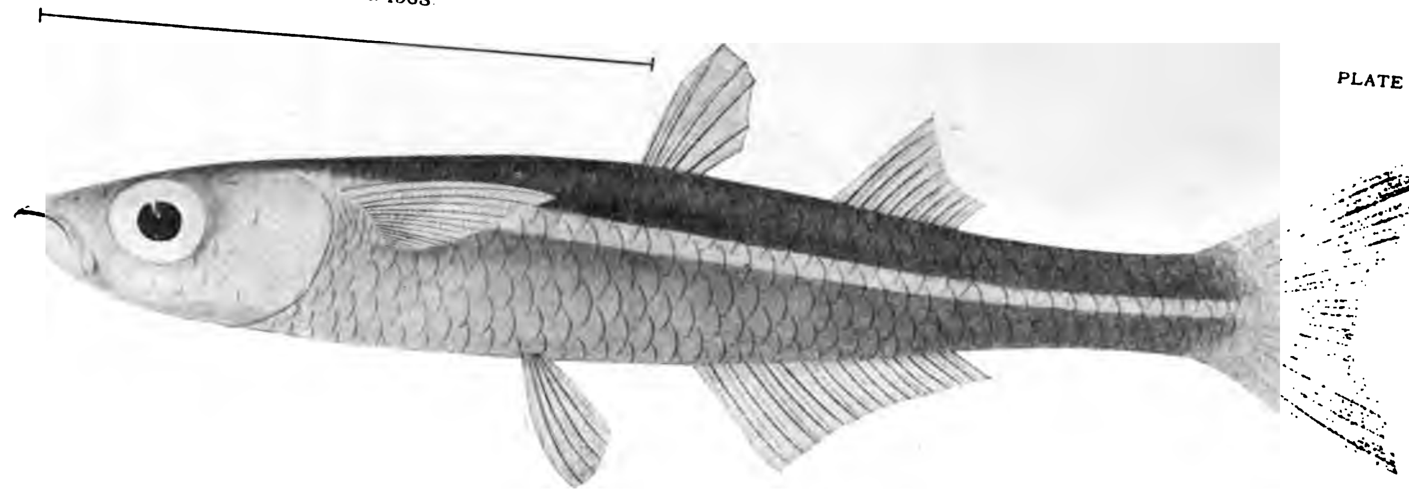


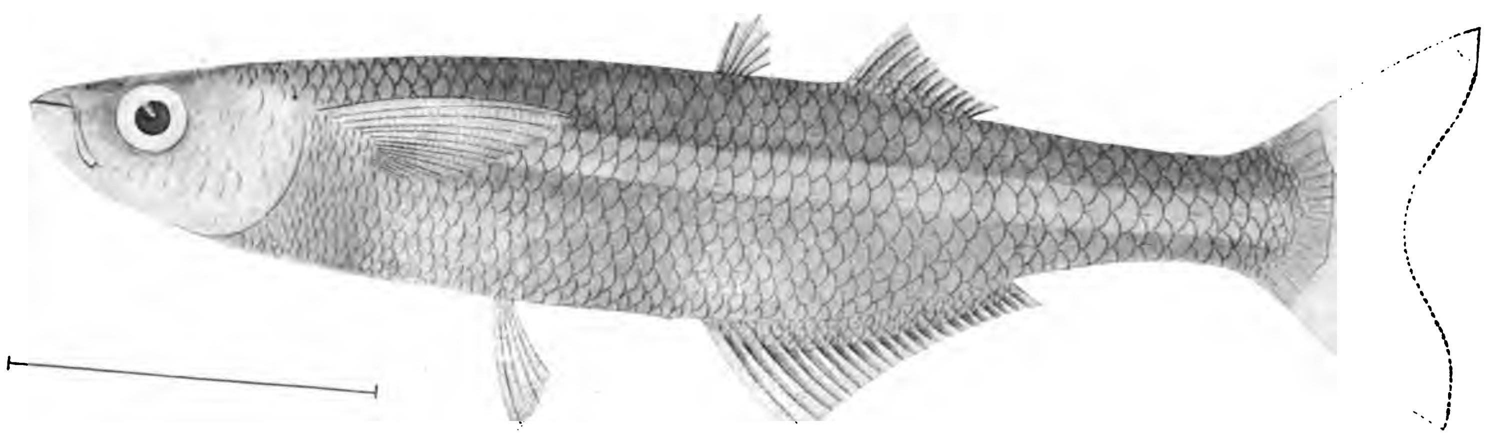
MOORE. NEW POLYCHÆTA.



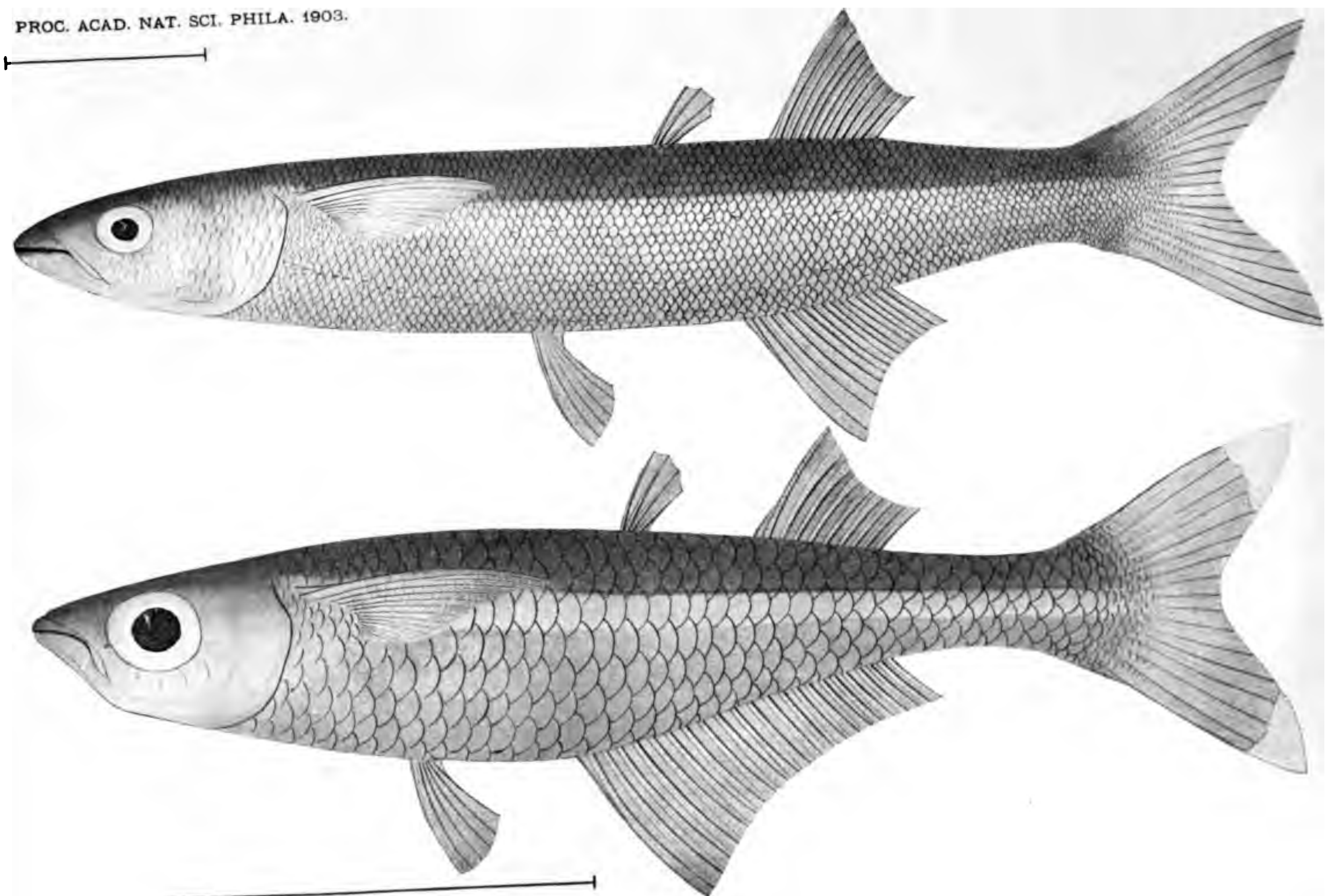
STONE. VARIATION IN VIOLETS.

PLATE XLII

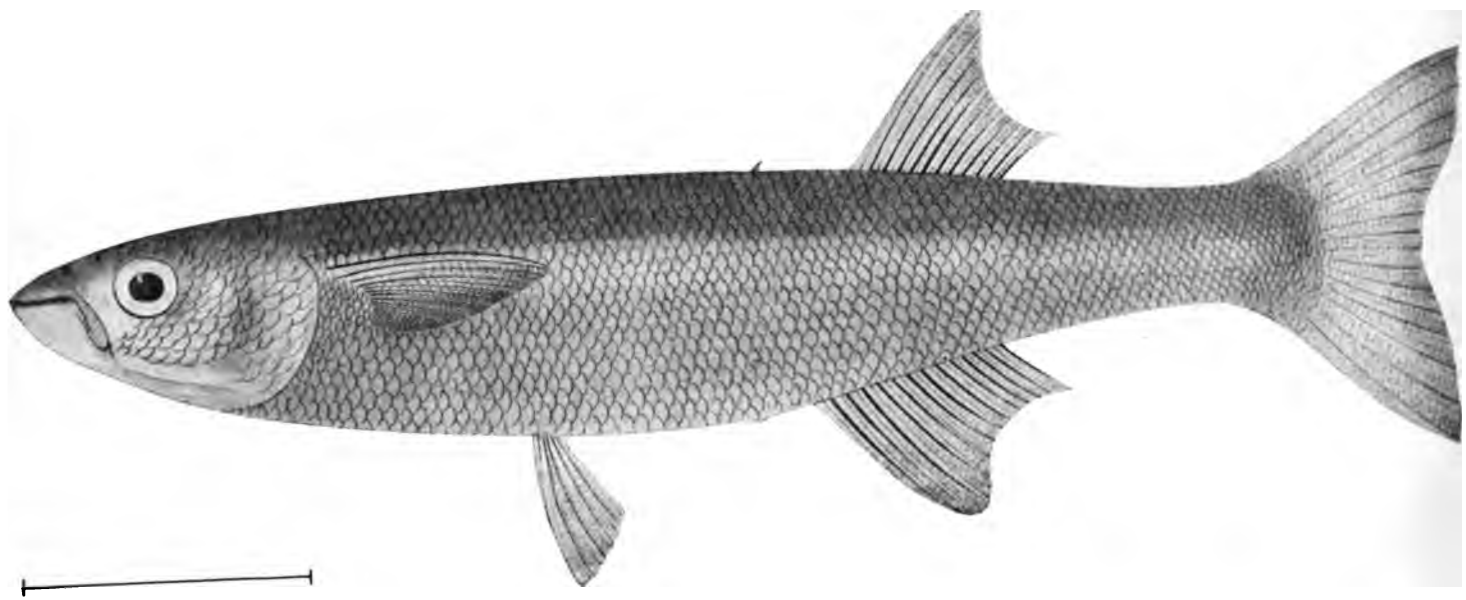




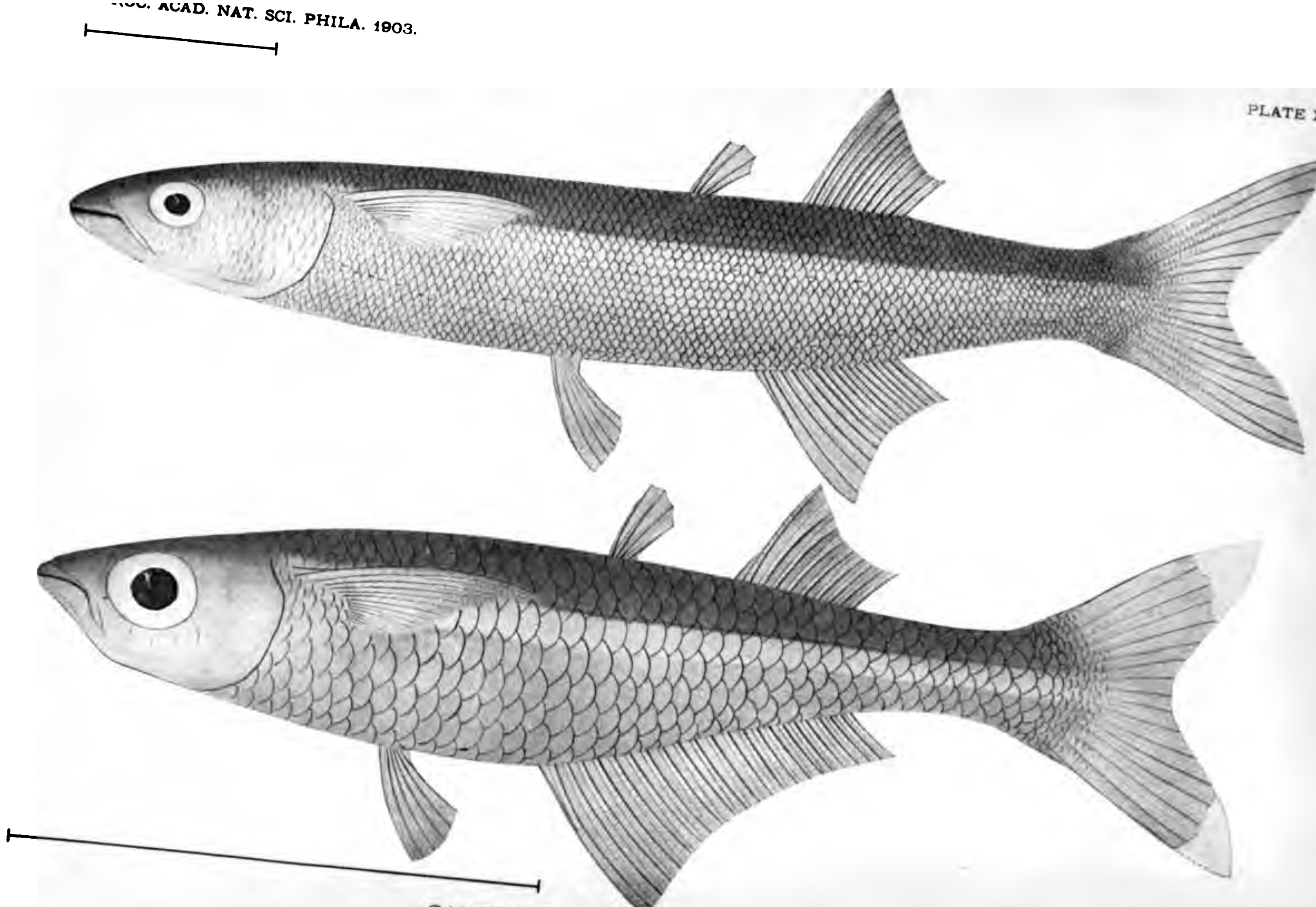
ISCHNOMEMBRAS GABUNENSIS FOWLER.
ATHERINOPS MAGDALENÆ FOWLER.



GASTEROPTERUS ARCHÆUS COPE.
THYRINA GUATEMALENSIS (GÜNTHER).



PROTISTIUS SEMOTILUS COPE.



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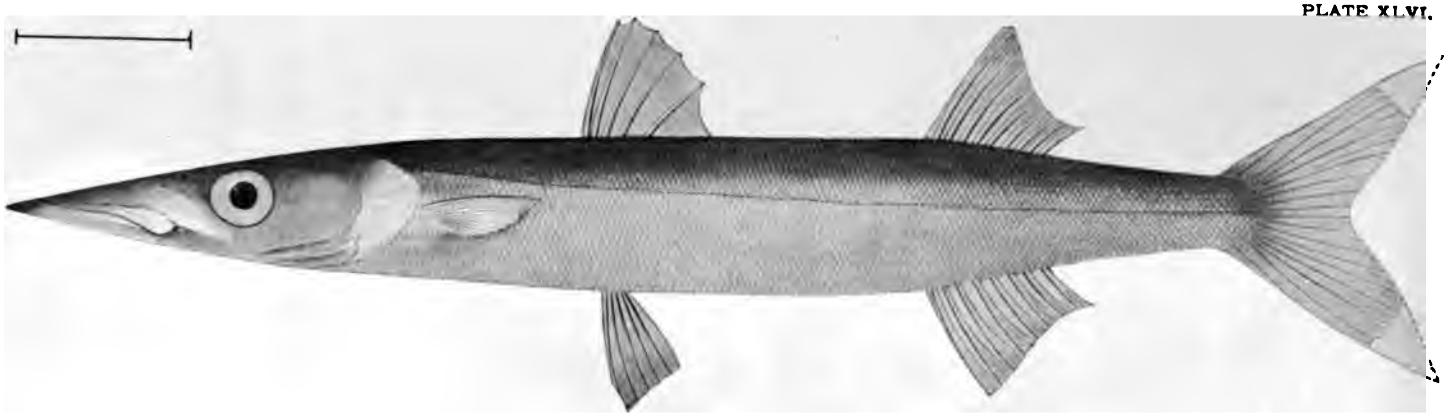
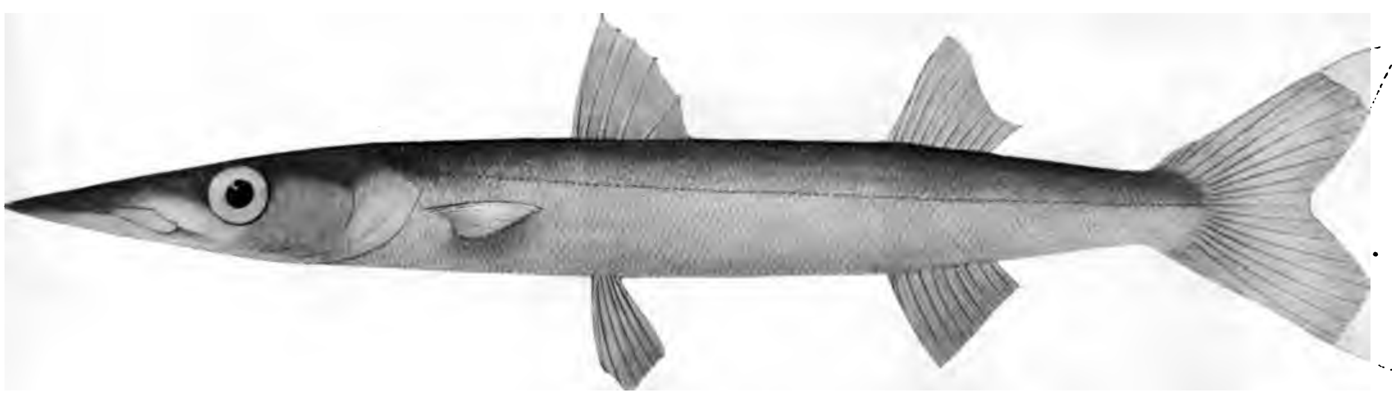
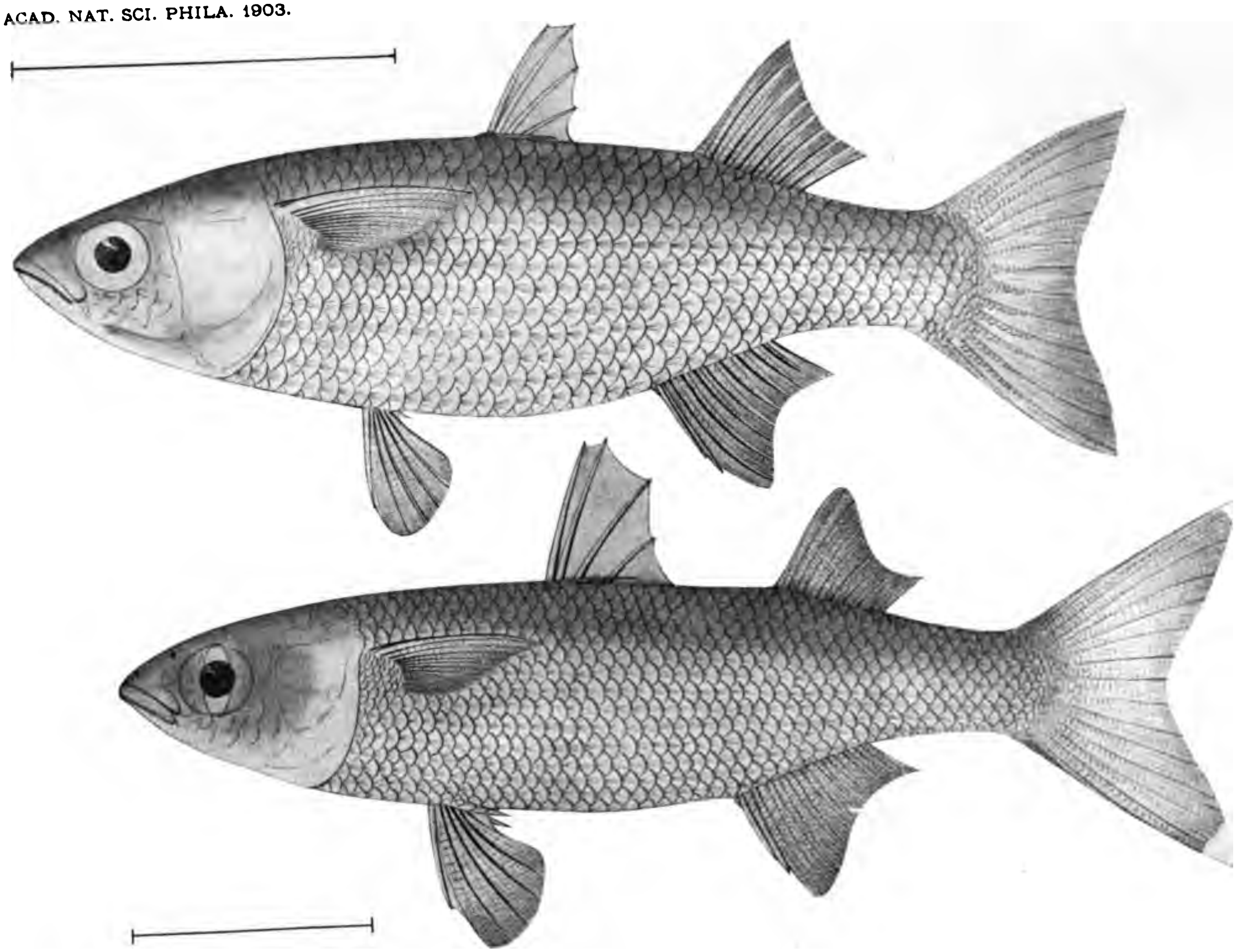
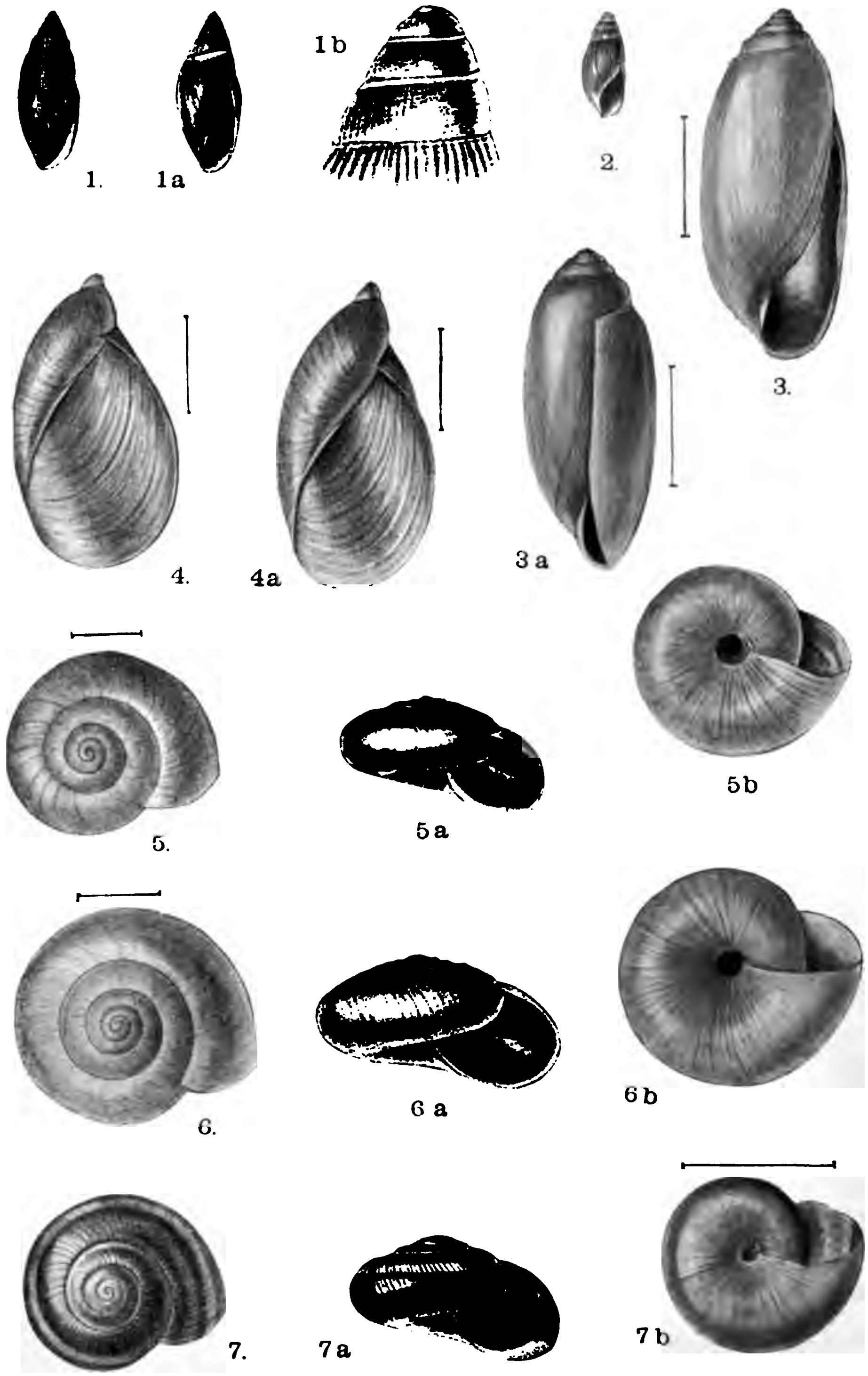




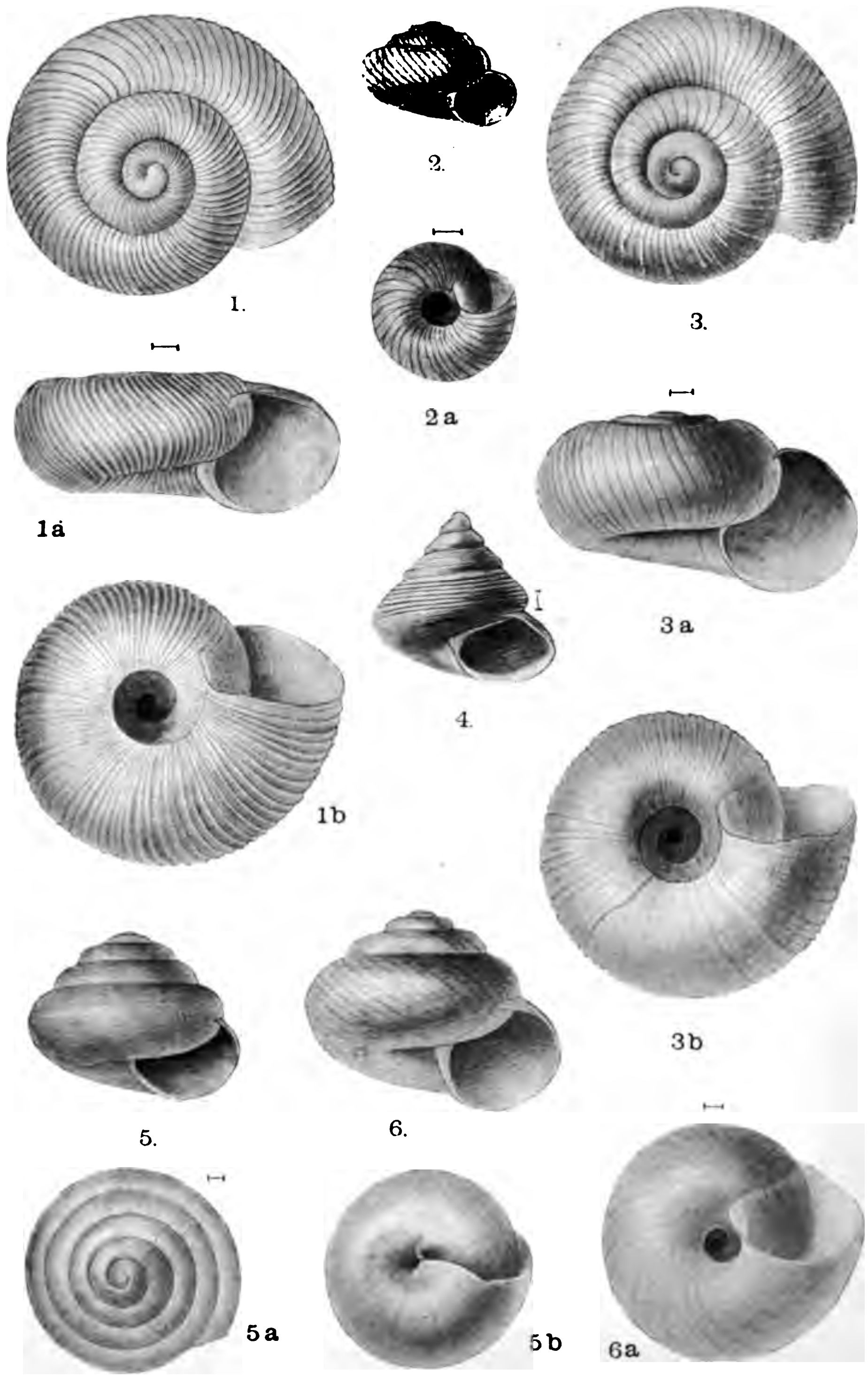
SPHYRÆNA TOME FOWLER.
SPHYRÆNA PICUDILLA POEY.



LIZA ALOSOIDES FOWLER.
MUGIL INCILIS HANCOCK.



PILSBRY. NEW MEXICAN MOLLUSCA.



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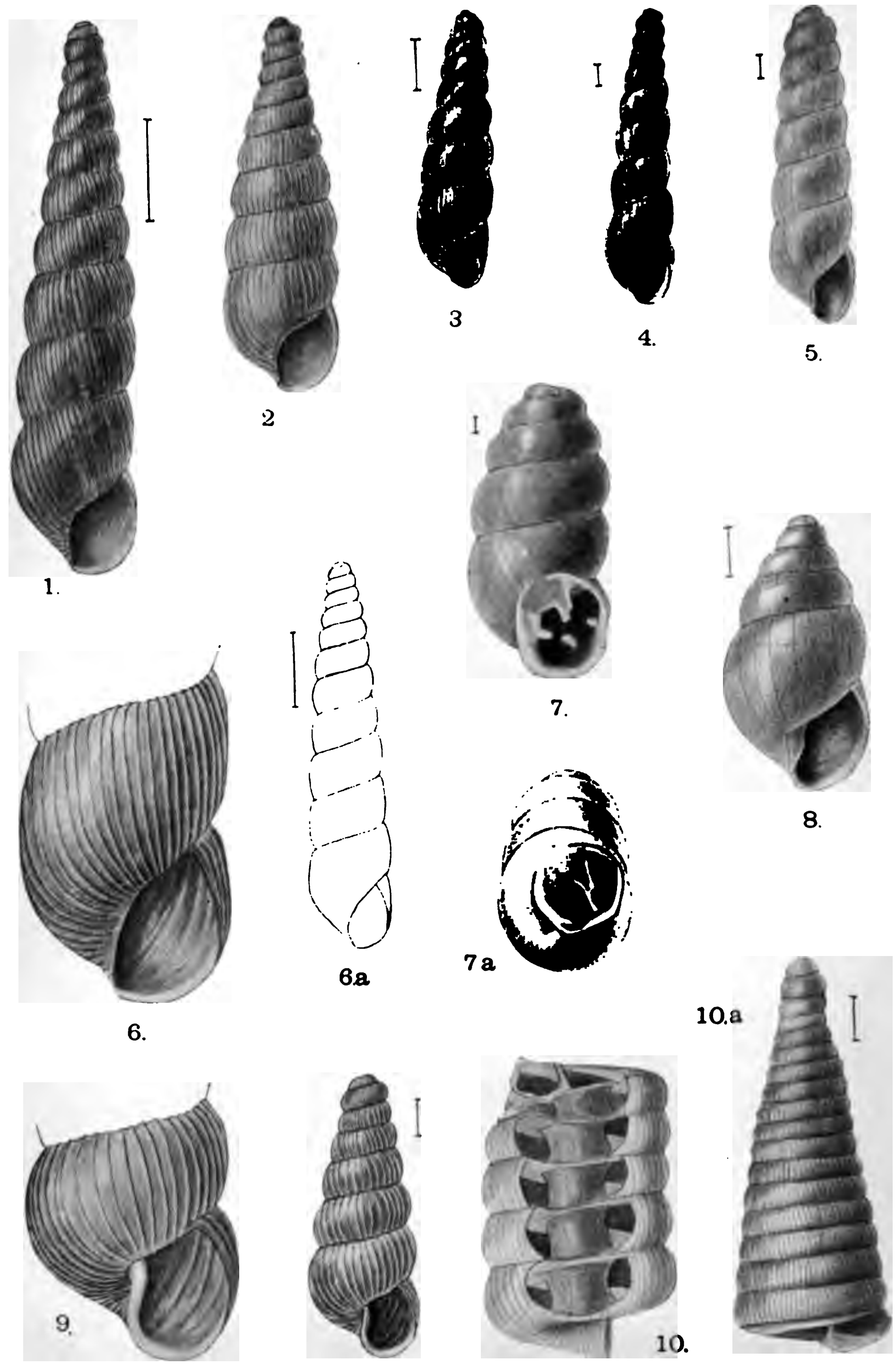

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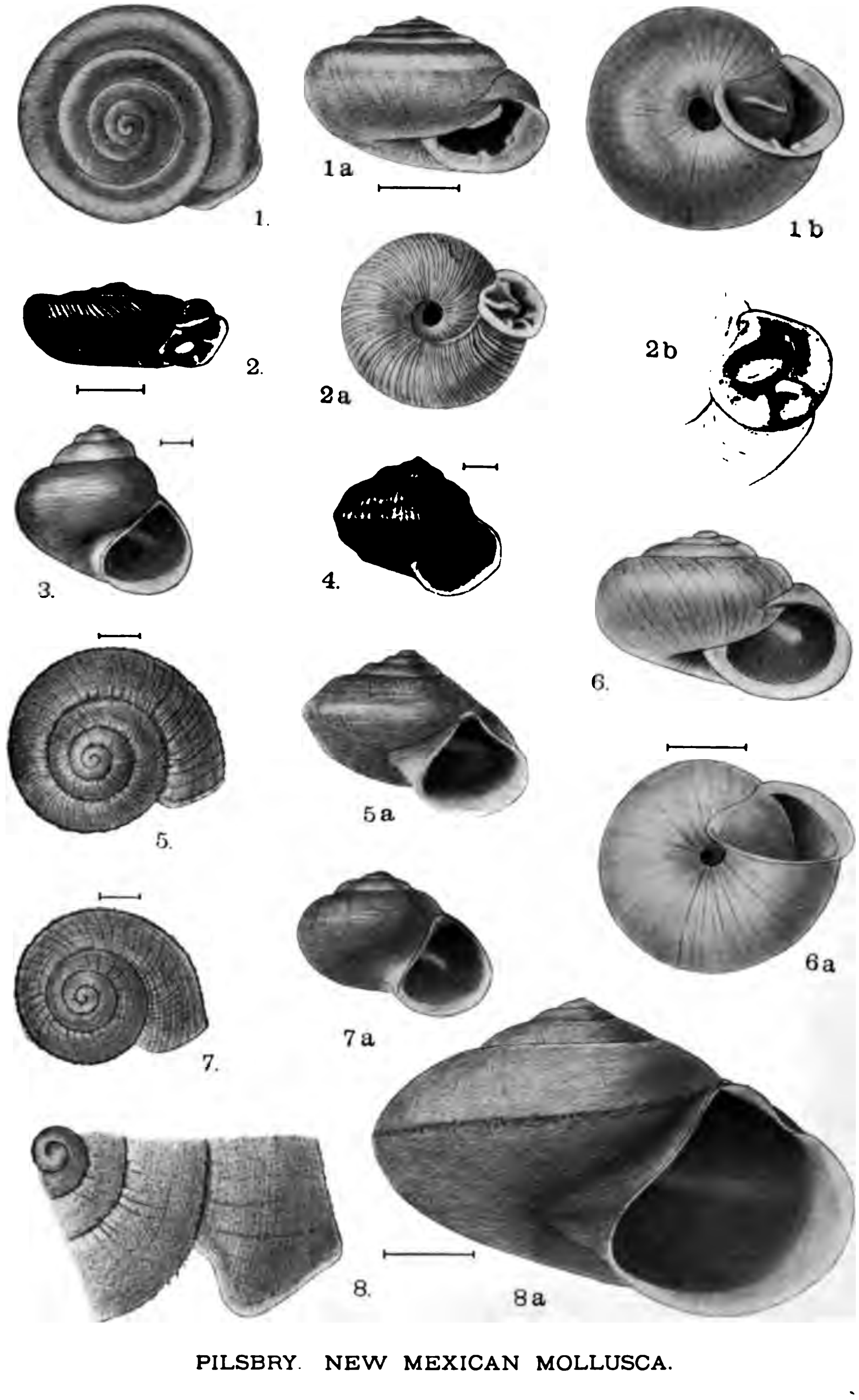

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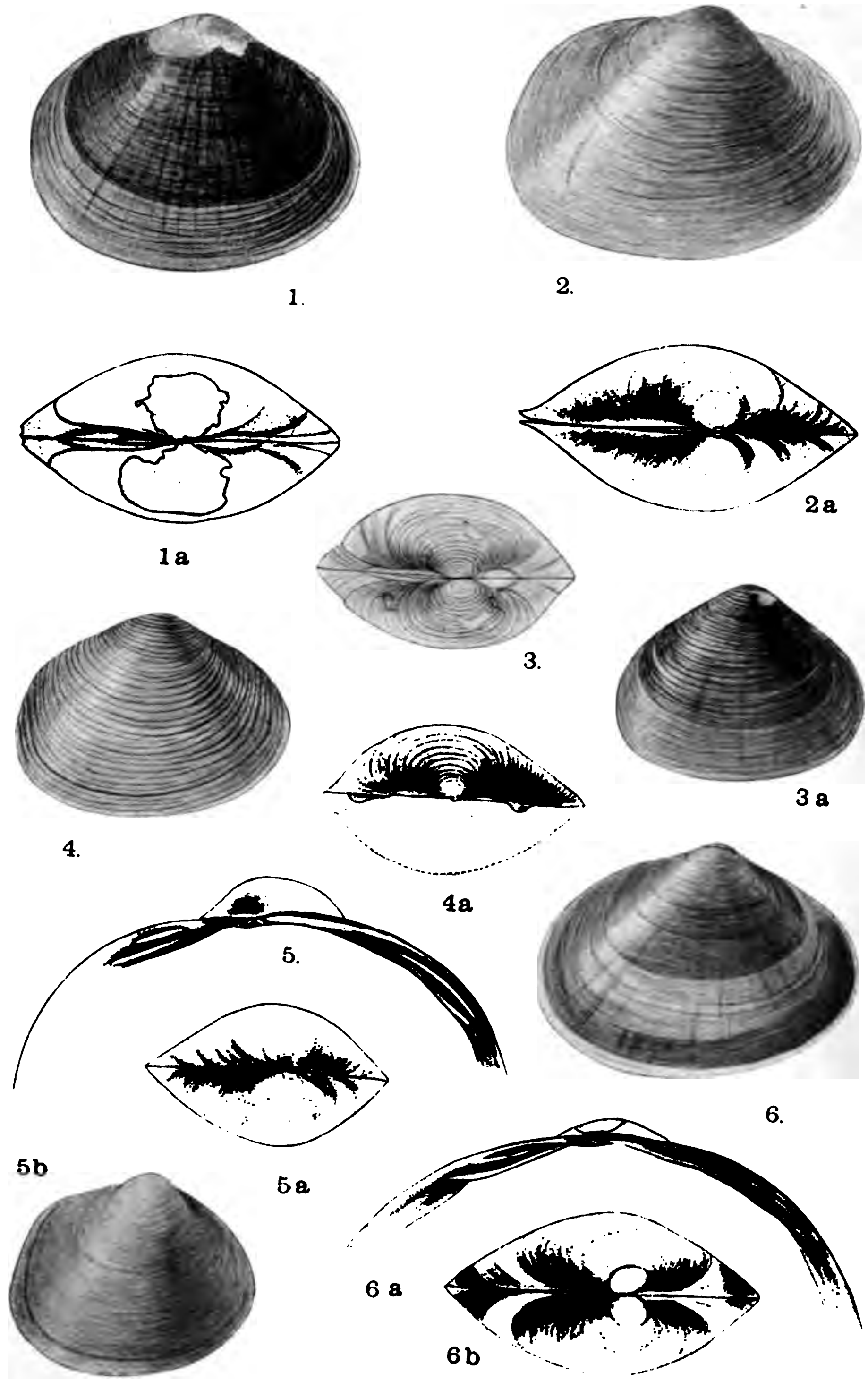

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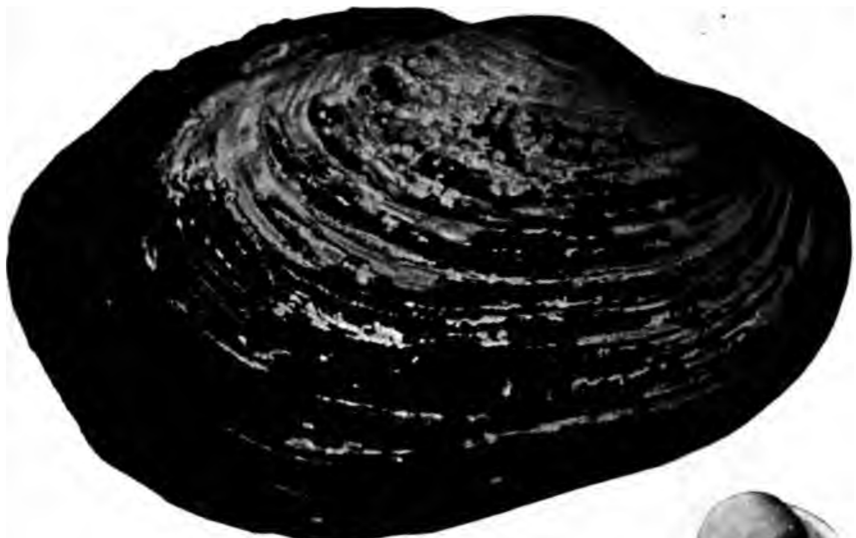

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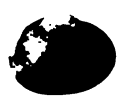

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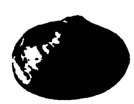

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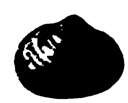

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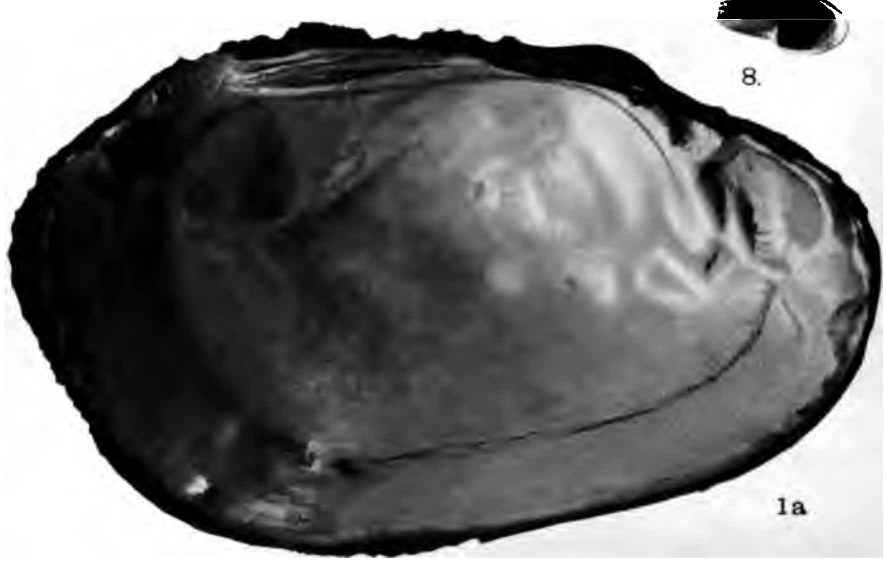

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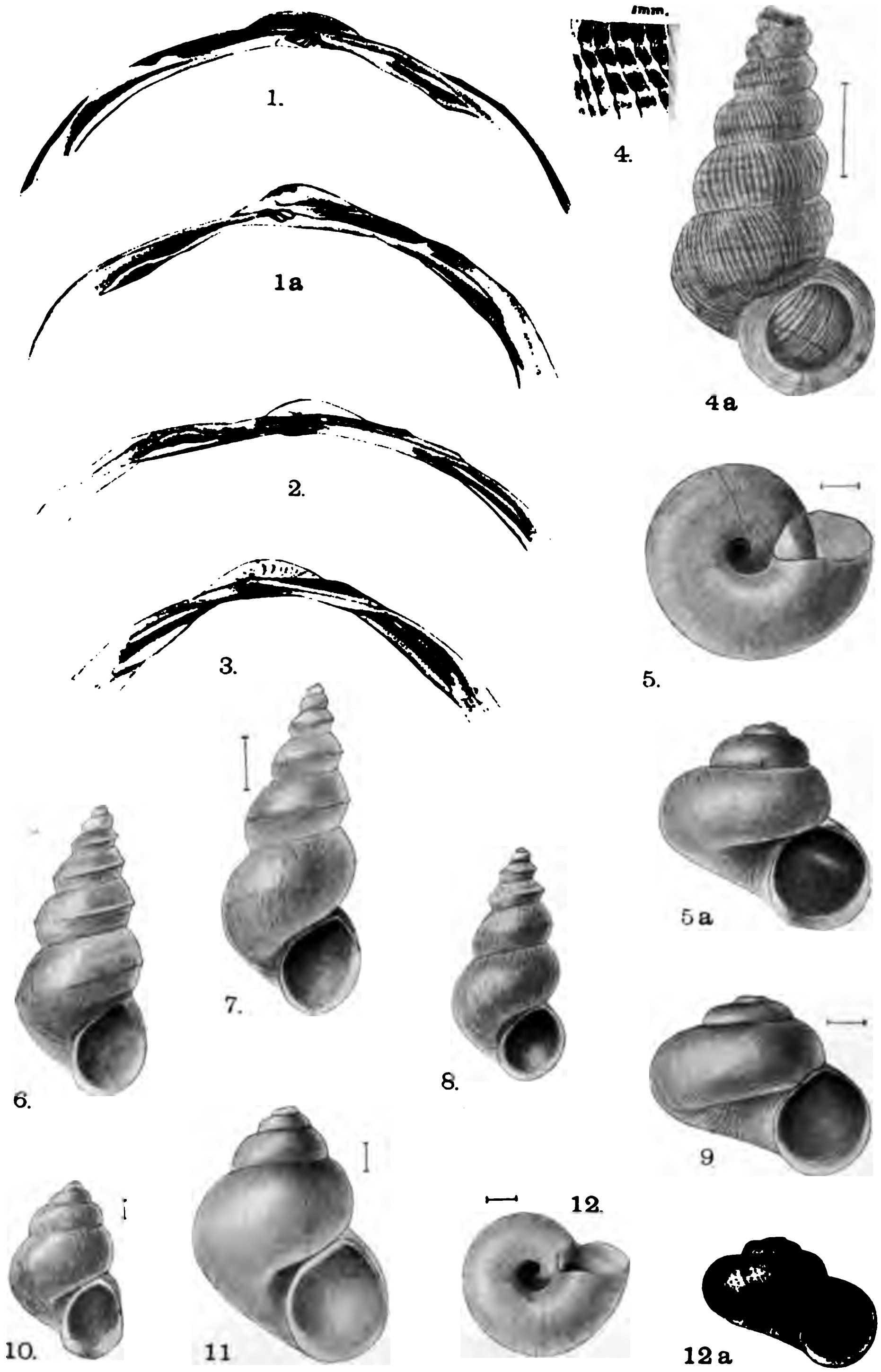

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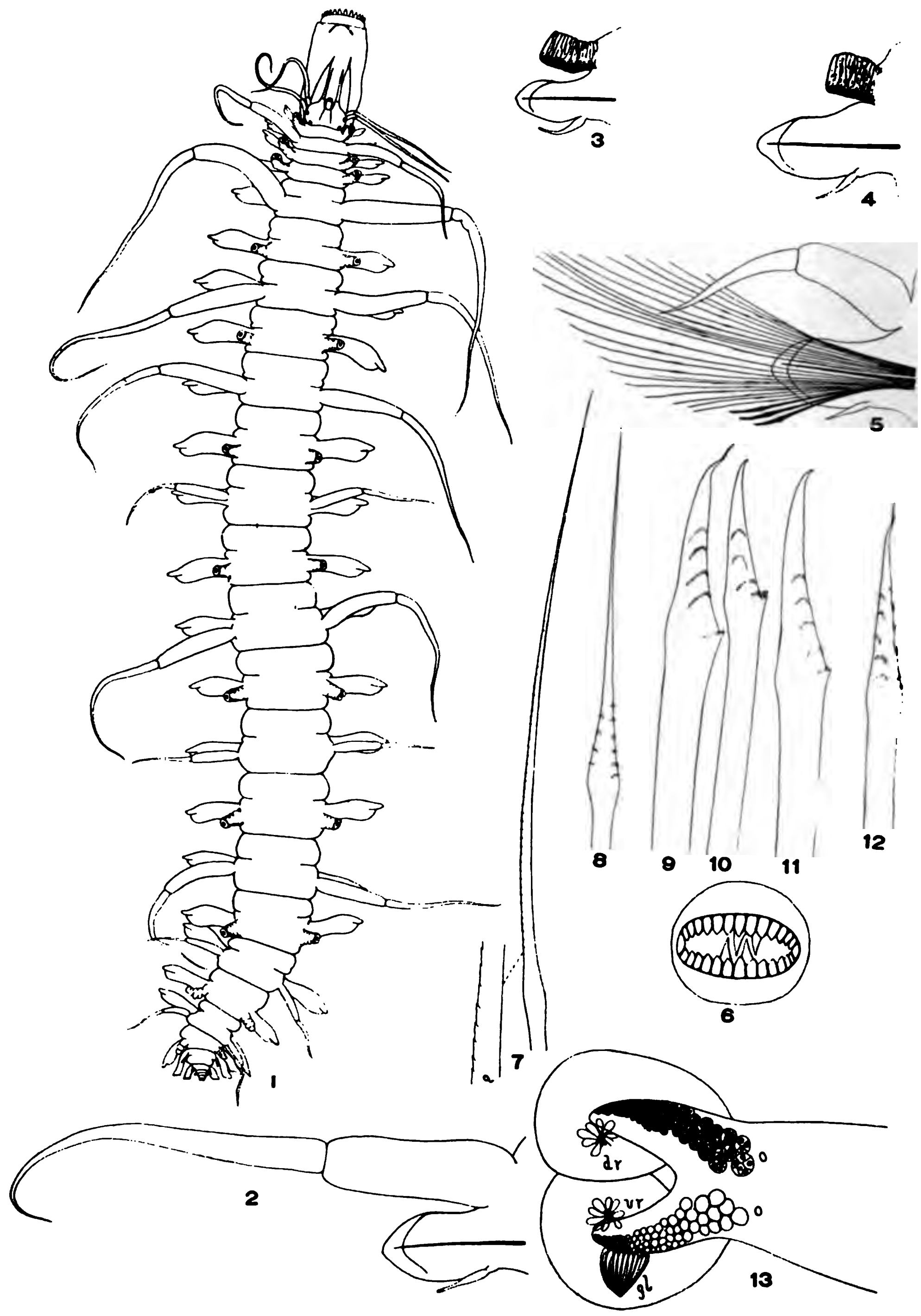

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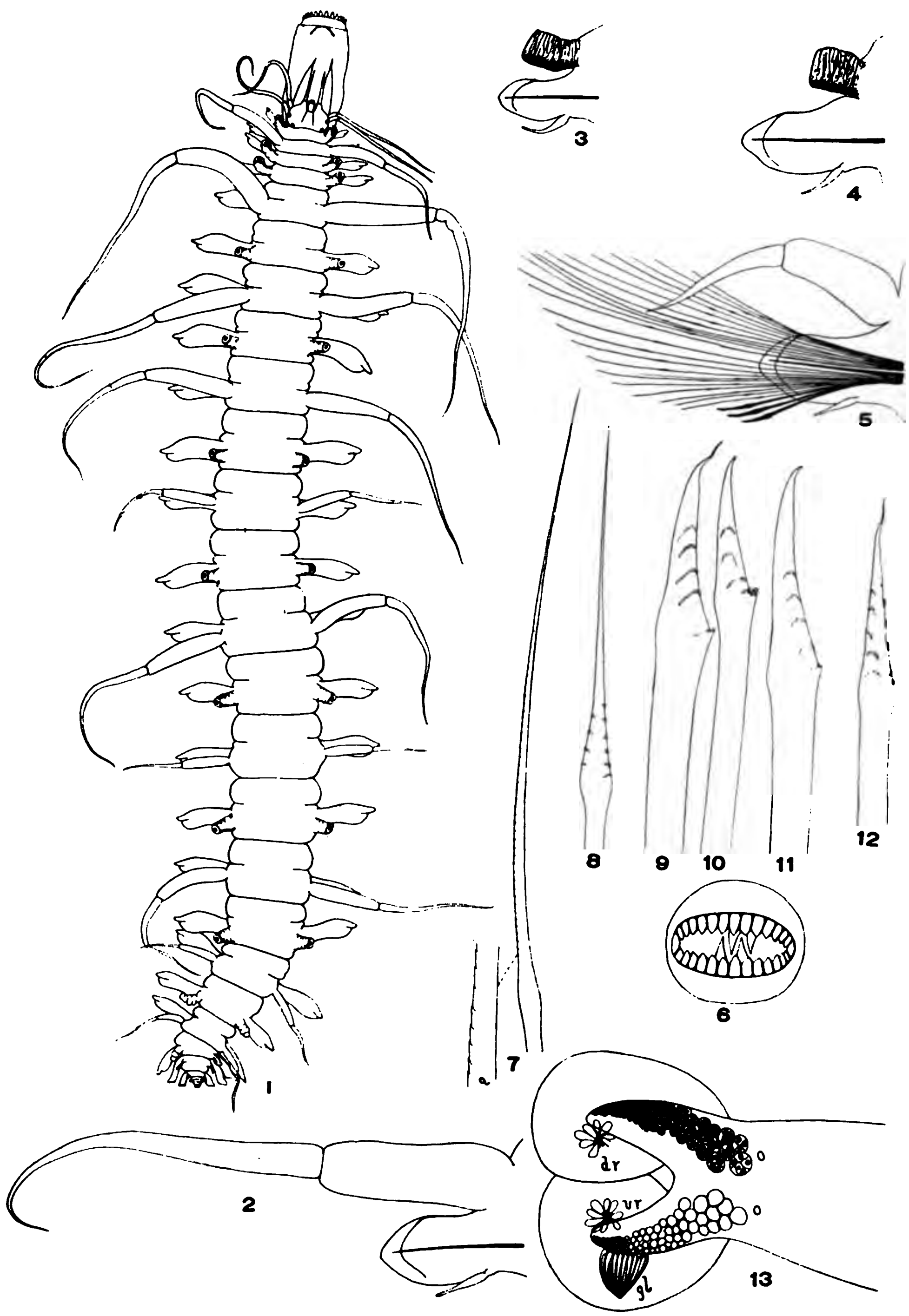

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